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Nutritional assessment of the children in pediatric intensive care unit with subjective global nutritional assessment and its relationship with the prognosis

Avaliação nutricional de crianças internadas em unidade de terapia intensiva pediátrica com avaliação nutricional global subjetiva e sua relação com o prognóstico

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ABSTRACT

Objective

This study aims to evaluate the nutritional status of patients hospitalized in pediatric intensive care unit with Subjective Global Nutritional Assessment and its relationship with prognosis.

Methods

A total of 150 patients in pediatric intensive care unit, 6 months to 17 years (mean age: 4.94±4.84, M/F:1.14), that were hospitalized for at least 7 days have been enrolled in this study. Weight, height, mid-upper arm circumference, and triceps skin fold thickness were measured. The anthropometric measurements were recorded. The Nutrition type (enteral, parenteral or both) during hospitalization, PRISM III mortality risk score, and Subjective Global Nutritional Assessment was a determinent part of the study.

Results

At hospitalization 18.7% of the patients were moderately malnourished, 32% were severely malnourished and 49.3% were normal. According to PRISM III score 41.3% of the patients were classified as normal, 29.3% as moderate and 29.3% as severe. A strong positive correlation was found between Subjective Global Nutritional Assessment and all of the anthropometric measurements. A significant statistically difference has been observed between malnutrition status at hospitalization concerning weight for age, height for age, weight for height and body mass index ($p<0.01$). It was also analysed a very relevant statistically connection between malnutrition classification and lenght of hospital stay ($p<0.05$). The result rate considerably higher in patients with severe malnutrition ($p<0.05$).

Conclusion
A strong correlation was found between Subjective Global Nutritional Assessment and anthropometric measurements. Also significant correlation was found between malnutrition score at admission and prognosis in this study.

Keywords: Malnutrition. Pediatric intensive care. Prognosis. Subjective Global Nutritional Assessment.

RESUMO

Objetivo
O objetivo do estudo foi avaliar o estado nutricional de pacientes internados em unidades de terapia intensiva pediátrica por meio da Avaliação Nutricional Global Subjetiva e sua relação com o prognóstico.

Métodos
Um total de 150 pacientes em comunidades de terapia intensiva pediátrica entre 6 meses e 17 anos (idade média: 4,94±4,84, M/F:1,14) que foram hospitalizados por menos de 7 dias para todos estão incluídos neste estudo. As medidas antropométricas foram registradas. Foram determinados o tipo de nutrição (enteral, parenteral ou ambas) durante a internação, o score de risco de mortalidade PRISM III e a Avaliação Nutricional Global Subjetiva.

Resultados
Na internação 18,7% dos pacientes apresentavam desnutrição moderada, 32% desnutrição grave e 49,3% eram normais. De acordo com o score PRISM III 41,3% dos pacientes foram classificados como normais, 29,3% como moderados e 29,3% como graves. Foi encontrada uma correlação positiva entre a Avaliação Nutricional Global Subjetiva e todas as medidas antropométricas. Observou-se uma diferença estatistica significativa entre estado de desnutrição na internação, peso para idade, altura para idade, peso para altura e índice de massa corporal (p<0,01). Uma relação estatisticamente relevante foi encontrada entre a classificação de desnutrição e a duração da internação hospitalar (p<0,05). A taxa de resultados foi consideravelmente maior em pacientes com desnutrição grave (p<0,05).

Conclusão
Foi encontrada forte correlação entre a Avaliação Nutricional Global Subjetiva e as medidas antropométricas neste estudo. Também foi encontrada correlação entre o score de desnutrição na admissão e o prognóstico neste estudo.

Palavras-chave: *Desnutrição. Terapia intensiva pediátrica. Prognóstico. Avaliação Nutricional Global Subjetiva.*

INTRODUCTION

Malnutrition is defined as a deficiency over energy, protein and micronutrient that can negatively affect growth, development and other relevant outcomes due to an imbalance between nutrient intake and requirement [1]. It is the most important cause of mortality and morbidity in children in developing countries [2], associated with 45% of children's deaths under the age of five [3].

Malnutrition, including undernutrition and overnutrition, is frequently observed among children admitted to Pediatric İntensive Care Unit (PICU) and associated with mortality and morbidity. The importance of nutrition has come to the fore with the nutritional guideline for the patients in PICU published by American Parenteral Enteral Nutrition Society in 2009 [4], and the studies on this subject have increased in recent years [5-18]. Nutritional status and nutritional pathway has been shown to affect mortality, infectious complications, and Lenght of Hospital Stay (LOS) in PICU [4,5,19].

Subjective Global Nutritional Assessment (SGNA) is a comprehensive screening method which reflects the clinical decision combining the patient's nutritional history (rating of growth, weight changes, dietary intake, gastrointestinal symptoms, functional capacity, and any metabolic stres) and physical examination findings (loss of subcutaneous fat, muscle wasting, and/or edema) in assessing nutritional status classified as normal/well nourished, moderate malnutrition, or severe malnutrition [20].

This study aims to evaluate the nutritional status and risk scoring of patients hospitalized in the PICU with SGNA, which is a simple, noninvasive, comprehensive and cost-effective screening method, in order to establish the contribution of nutrition management to the prognosis.

METHODS

A total of 150 patients between the ages of 6 months to 17 years who were hospitalized for at least 7 days in PICU between September 2019 and January 2021 were enrolled in this single-center prospective cross-sectional study. The patients who were younger than 6 months, older than 17 years that did not agree to participate in the study or did not give informed consent were excluded from the study. This study was conducted in a PICU of a tertiary hospital.

The nutritional status of the patients were determined by SGNA at admission. A SGNA questionnare form was created (Figure 1). The SGNA was performed by the same physician at the time of admission to PICU. The patient's medical history as: food and drug intake, changes in weight, presence of gastrointestinal symptoms, functional capacity and presence of acute stress were very determinant to the analysis. A physical examination was performed to look for signs of subcutaneous fat stores, muscle wasting and edema. Were measured weight, height, Mid-Upper Arm Circumference (MUAC) and Triceps Skin Fold Thickness (TSFT). The anthropometric measurements such as Weight For Age (WFA), Height For Age (HFA), Weight For Height (WFH) (in patients <2 years of age), Body Mass İndex (BMI) (in patients >2 years of age) were recorded. Overall, the rating is subjective and not based on a numerical scoring system. When the SGNA questionnare forms were evaluated it appeared that there are more checkmarks on the right side of the form, which indicates that the child is malnourished, whereas if most of the checkmarks are on the left, the child is likely normal (Figure 1) [20]. Other components such as child or caregiver self-reports are also used to support this rating.

According to SGNA, a normal/well-nourished child that has normal growth and weight gain, adequate food intake, no gastrointestinal symptoms, little or no signs of weakness on physical examination, normal functional capacity, and has a normal rating in all categories or is recovering rapidly from a suspected/moderately malnourished condition despite some muscle wasting, decrease in fat sores and weight gain [20]. Moderate malnutrition is defined by having clear signs of decreased growth, weight, and food intake, and also may be having signs of decreased fat stores, muscle mass and functional capacity; a moderate classification in most or all categories have the potential to progress to severe malnutrition [20]. Severely malnourished patients have progressive malnutrition with declining tendency in most or all categories, along with fat loss, muscle wasting, >10% weight loss, decreased food intake, excessive gastrointestinal losses, acute metabolic stress and definite loss of functional capacity [20]. Theses patients have a severe degrading, with no signs of improvement in most or all categories.

The body weight of infants was measured with an infant scales, the bed scales was destined to unconscious and/or immobile patients, and the children that could stand were weighed on their feet. The height of infants was measured with a tape measure, for the unconscious children and/or immobile patients was needed some help from the staff, and the children that could stand were measured on their feet. The MUAC was measured with a tape measure on the left arm, and TSFT was measured three times with a caliper to determinate the mean value.

PEDIATRIC SGNA RATING FORM
Consider severity and duration of changes, as well as recent progression when rating each item

NUTRITION-FOCUSED MEDICAL HISTORY	SGNA SCORE		
	Normal	Moderate	Severe
Appropriateness of Current Height for Age (stunting) a) Height percentile: __________ ☐ just below 3rd centile ☐ far below 3rd centile			
b) Appropriate considering mid-parental height[a]?: ☐ yes ☐ no			
c) Serial growth[b]: ☐ following centiles ☐ moving upwards on centiles ☐ moving downwards on centiles (gradually or quickly)			
Appropriateness of Current Weight for Height (wasting) Ideal Body Weight = ________ kg Percent Ideal Body Weight: __ __ __ % ☐>90% ☐75-90% ☐<75%			
Unintentional Changes in Body Weight a) Serial weight[b]: ☐ following centiles ☐ crossed ≥ 1 centile upwards ☐ crossed ≥ 1 centile downwards			
b) Weight loss: ☐< 5% usual body weight ☐5-10% usual body weight ☐>10% usual body weight			
c) Change in past 2 weeks: ☐ no change ☐ increased ☐ decreased			
Adequacy of Dietary Intake a) Intake is: ☐ adequate ☐ inadequate – hypocaloric ☐ inadequate – starvation (ie, taking little of anything)			
b) Current intake versus usual: ☐ no change ☐ increased ☐decreased			
c) Duration of symptoms: ☐< 2 weeks ☐≥ 2 weeks			
Gastrointestinal Symptoms a) ☐ no symptoms ☐ one or more symptoms; not daily ☐ some or all symptoms; daily			
b) Duration of symptoms: ☐< 2 weeks ☐≥ 2 weeks			
Functional Capacity (nutritionally related) a) ☐ no impairment energetic, able to perform age-appropriate activity ☐ restricted in physically strenuous activity, but able to perform play and/or school activities in a light or sedentary nature; less energy; tired more often ☐l ittle or no play or activities, confirmed to bed or chair > 50% of waking time; no energy; sleeps often			
b) Function in past 2 weeks: ☐no change ☐increased ☐decreased			
Metabolic Stress of Disease ☐no stress ☐moderate stress ☐severe stress			

[a]Mid-parental height: Girls: subtract 13cm from the father's height and average with the mother's height; Boys: add 13cm to the mother's height and average with the father's height; Thirteen cm is the average difference in height of women and men. For both girls and boys, 8.5cm on either side of this calculated value (target height) represents the 3rd to 97th percentiles for anticipated adult height (29).
[b]30% of healthy term infants cross one major percentile and 23% cross two major percentiles and 23% cross two major percentiles during the first 2 years of life, typically towards the 50th percentile rather than away from it. This is normal seeking of the growth channel.

Figure 1 – Subjective Global Nutritional Assessment questionnaire form.

To assess both acute and chronic malnutrition was used a WFA and the children classified with standard deviation score (SDS) ≤ -2 for WFA were diagnosed as underweight. The HFA is the indicator of linear growth. Children with SDSs ≤ -2 for HFA were considered shorter indicating chronic malnutrition. In the first 2 years of life is used WFH to classify, instead of BMI, and children with SDSs ≤ -2 for WHF were considered as weak and having acute malnutrition. The WFA, HFA, WFH and BMI were calculated according to the child growth standards accepted by WHO [21], and our national growth charts reported by Olcal Neyzi [22]. In this study WFA, HFA, and WFH were used under 2 years of age and WFA, HFA, and BMI were used in patients older than 2 years. Z-score (SDS) >-1 was considered normal, values between -1 ve-2 were considered as moderate malnutrition, and those with >-2 considered as severe malnutrition.

The MUAC is an indicator of muscle mass and subcutaneous fat stores, in which <12.5 cm is considered malnutrition, while <11 cm is severe malnutrition [23]. The TSFT shows triceps muscle thickness and, in terms of malnutrition in children between 1-4 years, <5 mm is considered a significant number.

Pediatric Risk of Mortality score (PRISM III), which is used for evaluation of mortality and morbidity, consists of physical examination (Glasgow coma score, pupillary response), vital signs (heart rate (beat/min), systolic blood pressure (mmHg), temperature (^{o}C), white blood cell count (cell/mm^3), platelet count (cell/mm^3), potassium (meq/L), glucose (mmol/L), urea (mmol/L), creatinine (mmol/L), pH, PaCO2 (mmHg), PaO2/FiO2 (mmHg), and Prothrombin time (PT)/ Partial thromboplastin time (PTT) (sec); the results of the PRISM's tests are given back within the first 24 hours of admission to the intensive care unit [24]. Patients with a PRISM III score <4 were considered normal, those with 4-8 were moderate, and those with >8 were considered severe [24].

Hemoglobin, albumin, C-Reactive Protein (CRP) and Absolute Lymphocyte Count (ALC) results were taken at admission, and reexamined weekly, during hospitalization.

During the hospitalization was determined the nutritional status (enteral, parenteral or both). The pediatric nutritional risk score with SGNA was evaluated as normal, moderately malnourished, and severely malnourished. The nutritional status, anthropometric measurements and malnutrition score were re-evaluated weekly, during the hospitalization in PICU.

A written consent was taken from each patient or parents. The study was approved by the Ethics Committee of Sisli Etfal Training and Research Hospital (nº 2524, 09/17/2019).

A statistical analysis was performed using the Number Cruncher Statistical System in 2007 (Kaysville, Utah, U.S.A.). The descriptive statistics were given as mean, standard deviation, median, frequency, minimum and maximum for numerical variables. The conformity of the quantitative and the normal distribution was tested with Shapiro-Wilk test, by and graphical examinations. The Kruskall-Wallis test was used for comparisons of quantitative variables that did not show normal distribution, and the Dunn-Bonferroni test was used for post hoc evaluations. Spearman's coefficient correlation was used to evaluate the relations between the variables. Pearson Chi-Square test and Fischer-Freeman Halton test were used to compare qualitative data. The *p*-values of <0.05 were considered statistically significant.

RESULTS

The mean age between the 150 patients was 4.94±4.84, and M/F was 1.14. In addition, 42% (n=63) of the patients were under 2 years of age, 19.3% (n=29) were between the ages of 3-4, 18% (n=27) were between 5-10 and 20.7% (n=31) were older than 10 years. Importantly, most of the patients had respiratory diseases, and in Table 1 is shown more of the the demographic and clinical characteristics of the patients.

Table 1 – The demographic and clinical characteristics of the patients.

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Demographic and clinical characteristics	Results
Age – mean±SD; median (IQR)	4.94±4.84; 2.82 (0.89-8.06)
Gender – n (%)	
Female	70 (46.7)
Male	80 (53.3)
Weight (kg) – mean±SD; median (IQR)	16.5±13.3; 12 (7.6-20)
Height (cm) – mean±SD; median (IQR)	94.7±32.2; 86 (70-114)
MUAC (cm) – mean±SD; median (IQR)	15.48±3.84; 15 (12.5-17.5)
TSFT (mm) – mean±SD; median (IQR)	21.95±7.63; 21 (17-25)
<11 mm	12 (8.1)
>12 mm	137 (91.9)

Table 1 – The demographic and clinical characteristics of the patients.

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Demographic and clinical characteristics	Results
Clinical diagnosis – n (%)	
Respiratory diseases	59 (39.3)
Infectious diseases	24 (16.0)
Neurological diseases	21 (14.0)
Postoperative	13 (8.7)
Gastrointestinal diseases	9 (6.0)
Cardiovascular diseases	4 (2.7)
Others	20 (13.3)
Malnutrition at admission – n (%)	
Normal	74 (49.3)
Moderate	28 (18.7)
Severe	48 (32)
Nutrition type – n (%)	
Parenteral	126 (84.0)
Enteral	12 (8.0)
Parenteral+enteral	12 (8.0)
PRISM III score – mean±SD; median (IQR)	5.66±5.2; 5 (1-8)
Normal – n (%)	62 (41.3)
Moderate – n (%)	44 (29.3)
Severe – n (%)	44 (29.3)
WFA – n, mean±SD; median (IQR)	
Admission	150, -1.65±2.27; -1.19 (-3.06-0.06)
1st week	150, -1.68±2.27; -1.32 (-3.0-0.1)
2nd week	47, -2.67±2.24; -2.63 (-3.64-0.76)
4th week	17, -2.34±1.42; -2.66 (-3.18-0.81)
HFA – n, mean±SD; median (IQR)	
Admission	149, -1.63±2.2; -1.56 (-2.97-0)
1st week	149, -1.68±2.19; -1.49 (-2.97-0.06)
2nd week	46, -2.43±2.48; -2.37 (-3.9-0.11)
4th week	17, -2.31±1.9; -2.83 (-3.19-1.53)
WFH – n, mean±SD; median (IQR)	
Admission	116, -0.27±2.08; -0.08 (-1.56-0.92)
1st week	116, -0,48±2,12; -0.24 (-1.79-0.77)
2nd week	38, -0.98±2.05; -0.66 (-2.21-0.55)
4th week	16, -0.53±1.76; -0.81 (-1.51-0.24)
BMI – n, mean±SD; median (IQR)	
Admission	148, -0.94±2.31; -0.66 (-1.94-0.46)
1st week	148, -1.06±2.29; -0.71 (-2.29-0.44)
2nd week	46, -1.64±2.31; -1.59 (-2.71-0.09)
4th week	17, -1.21±1.88; -1.55 (-2.34-0.41)
Biochemical parameters – n, mean±SD; median (IQR)	
Hemoglobin (g/dL)	
Admission	149, 10.46±2.06; 10.5 (9.2-11.9)
1st week	135, 10.1±1.82; 10 (9-11.1)
2nd week	42, 9.84±1.62; 9.8 (8.9-10.8)
4th week	17, 9.46±1.61; 9.4 (8.3-10.4)

Table 1 – The demographic and clinical characteristics of the patients.

Demographic and clinical characteristics	Results
Albumin (g/dL)	
Admission	139, 3.68±1.3; 3.6 (3.13-4.1)
1st week	124, 3.4±0.6; 3.32 (2.97-3.86)
2nd week	40, 3.23±0.57; 3.31 (2.94-3.66)
4th week	18, 3.56±0.49; 3.51 (3.38-3.96)
C-reactive protein (mg/L)	
Admission	149, 56.52±86.5; 12.54 (1.9-67.07)
1st week	134, 39.04±62.64; 12.18 (2.7-47.65)
2nd week	42, 37.19±52.07; 14.26 (3.43-55.3)
4th week	17, 17.45±32.69; 6.61 (2.59-16.11)
Absolute lymphocyte count (cell/mm3)	
Admission	148, 3384.5±2769.6; 2430 (1555-4560)
1st week	134, 4094.4±3043.5; 3365 (2130-5260)
2nd week	42, 3885.4±2196.6; 3470 (2070-5330)
4th week	17, 3617.0±1797; 3690 (2650-4450)
Prognosis – n (%)	
Exitus	9 (6.0)
Discharge	37 (24.7)
Transport to clinic	104 (69.3)

Note: BMI: Body Mass Index, HFA: Height For Age, MUAC: Mid-upper Arm Circumference, TSFT: Triceps Skin Fold Thickness, WFA: Weight For Age, WFH: Weight For Height.

While the malnutrition score was normal, with in 49.3% of the patients at admission, it decreased to moderate level in 3 children in the 1st week, and in one child in the 2nd week (Table 2). A severely malnourished child increased to moderate level.

Table 2 – Distribution of malnutrition scores.

Malnutrition	Normal		Moderate		Severe	
	n	%	n	%	n	%
Admission	74	49.3	28	18.7	48	32.0
1st week	71	47.3	31	20.7	48	32.0
2nd week	16	34.0	8	17.0	23	48.9
4th week	4	22.2	4	22.2	10	55.6

The relationship between anthropometric measurements, biochemical parameters and SGNA at admission is shown in Table 3. Although no significant correlation was observed between biochemical parameters and SGNA at admission (p>0.01), there was found a statistical relation between WFA, HFA, WFH, BMI and SGNA (p=0.001).

When the relation between MUAC, TSFT, and anthropometric measurements was evaluated, it appeared a positive resemblance between WFA, HFA, WFH, BMI and MUAC (r:0.505; p<0.01, r:0.350; p<0.01, r:0,559; p<0,01, and r:0.456; p<0.01, respectively). Moreover, another important aspect is the correlation between WFA, HFA, WFH, BMI and TSFT (r:0.506; p<0.01, r:0.314; p<0.01, r:0.581; p<0.01, and r:0.513 p<0.01, respectively). Nothing significant occured between MUAC, TSFT and biochemical parameters, hemoglobin, albumin, and CRP (p>0.05), but a negative and significant correlation was found between MUAC and ALC (p<0.01), along with a positive correlation between TSFT and ALC (p<0.01).

Table 3 – The relationship between anthropometric measurements, biochemical parameters and Subjective Global Nutritional Assessment at admission.

Malnutrition	N	Mean±SD	Median (IQR)	[a]*p*	[b]Post Hoc test
WFA					
Normal	74	0.13±0.98	0.07 (-0.67/0.89)	0.001**	N>O; 0.001
Moderate	28	-1.75±0.39	-1.66 (-2.1/-1.43)		N>A; 0.001
Severe	48	-4.32±1.55	-4.02 (-5.06/-3.18)		O>A; 0.001
HFA					
Normal	74	-0.18±1.43	-0.07 (-0.91/0.59)	0.001**	N>O; 0.001
Moderate	28	-1.92±0.99	-2.13 (-2.63/-1.29)		N>A; 0.001
Severe	47	3.75±1.95	-3.34 (-5.23/-2.32)		O>A; 0.011
WFH					
Normal	60	0.67±1.47	0.42 (-0.33/1.74)	0.001**	N=O; 0.138
Moderate	20	-0.31±1.11	-0.04 (-0.68/0.31)		N>A; 0.001
Severe	36	1.83±2.44	-2.06 (-3.03/-0.14)		O>A; 0.031
BMI					
Normal	73	0.37±1.27	0.4 (-0.55/1.22)	0.001**	N>O; 0.003
Moderate	28	-0.84±0.99	-0.73 (-1.62/-0.1)		N>A; 0.001
Severe	47	-3.03±2.59	-2.57 (-3.94/-1.58)		O>A; 0.001
Hb					
Normal	73	10.75±1.9	10.7 (9.7/11.9)	0.205	
Moderate	28	10.54±1.95	10.4 (8.7/12.25)		
Severe	48	9.97±2.3	10.05(8.85/11.5)		
Albumin					
Normal	66	3.65±0.74	3.67(3.21/4.14)	0.426	
Moderate	26	3.62±0.59	3.55 (3.13/4.15)		
Severe	47	3.75±2.03	3.52 (3.04/4)		
CRP					
Normal	73	64.2±88.9	18.9 (2/116.5	0.575	
Moderate	28	45.2±83.6	8.13 (1.1/24.9)		
Severe	48	51.41±85	12.9 (2.47/47.6)		
ALC					
Normal	73	3535.7±3127.7	2450 (1530/4650)	0.998	
Moderate	28	3272.5±2490.3	2430 (1580/4270)		
Severe	47	3216.6±2342.4	2420 (1680/4790)		

Note: ***p*<0.01. is statistically significant. [a]Kruskall Wallis test, [b]Dunn test. ALC: Absolute lymphocyte Count, BMI: Body Mass İndex, CRP: C-reactive Protein, Hb: Hemoglobin, HFA: Height For Age, MUAC: Mid-upper Arm Circumference, TSFT: Triceps Skin Fold Thickness, WFA: Weight For Age; WFH: Weight For Height.

Although it was found a statistically correlation between malnutrition score at admission and prognosis (*p*=0.046), nothing significant was observed between PRISM III score and prognosis (Table 4).

There was a major statistical difference in terms of LOS, among patients, according to malnutrition classification (*p*<0.02). The rate of severe malnutrition was importantly higher in those that were hospitalized for more than one month.

Table 4 – Correlations between malnutrition score at admission and prognosis.

Prognosis	Exitus		Discharge		Transport		*p*
	n	%	n	%	n	%	
Malnutrition							
Normal	1	11.1	19	51.4	54	51.9	
Moderate	2	22.2	4	10.8	22	21.2	0.046
Severe	6	66.7	14	37.8	28	26.9	
Prism III score							
Normal	2	22.2	15	40.5	45	43.3	
Moderate	2	22.2	14	37.8	28	26.9	0324
Severe	5	55.6	8	21.6	31	29.8	

Note: $p<0.05$ is statistically significant.

DISCUSSION

Malnutrition is associated with a poor prognosis in hospitalized patients and causes increased risk of infection, difficulty in wound healing, wasting of muscle mass, increased LOS, mortality and morbidity. An early detection of malnutrition by clinicians allows the provision of guidelines to prevent deterioration of patient's nutritional status and promote their recovery.

Until this date, eight screening methods for determining nutritional status have been used for hospitalized children and adolescents, but there is no consensus on which method is better than the others [25,26]. Screening Tool for Risk on Nutritional Status and Growth (STRONGkids) and SGNA are widely used in clinical practice [10]. In addition, are recommended to be used to determine the nutritional status of children [11-13, 25-33] the: Nutritional Risk Score, Pediatric Nutritional Risk Score, Pediatric Yorkhill Malnutrition Score (PYMS), Pediatric Nutrition Screening Tool (PNST), Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP).

The SGNA has been reported as the first valid subjective method for evaluating nutritional status in critically ill children [6]. It is a useful method for predicting nutrition-associated morbidities and determining malnutrition in PICU, but was based on a practitioner's clinical judgment rather than objective and quantitative measurements [20].

The SGNA has been used as a screening tool in hospitalized children, children with chronic diseases and malignities [34-36]. Pawaria et al. [36] stated that SGNA, in contrast to anthropometric measures, is a better nutritional assessment tool and it is reliable, comprehensive and predicts poor outcome in childhood chronic liver disease. Ouyang et al. [34] reported that STRONGkids is a simple, predictive and time-saving tool that is strongly recommended to be used in nutritional-risk screening on admission, and also, SGNA is an effective and comprehensive measurement tool to evaluate children's nutritional status. In our country, the SGNA has not been used for malnutrition screening before and this study, that was carried out in our hospital, was the first one.

Ong et al. [16] compared two nutrition screening tool, STAMP and SGNA in their study. Respectively, SGNA and STAMP identified 45% and 79% of the hospitalized children to be at risk of malnutrition. They concluded that, in detecting children who were malnourished, SGNA had a 4-fold higher specificity (70.4%) than STAMP (18.1%).

In this study, the ages at diagnosis were between 6 months and 16.2 years, and the mean age was 4.94±4.84 years, similarly with the studies conducted by Vermilyea et al. [6] and Minocha et al. [37].

Minocha et al. [37] 46.7% of our patients were females, 53.3% were males and M/F were 1.14. In the study of Vermilyea et al. [6] it has been reported as 1.6 and 1.2 in the study of Minocha et al. [37]. In this study, the most common diagnosis of the patients was respiratory diseases (39.3%), whereas Vermilyea et al. [6] has reported cardiovascular diseases (45%) as the most common diagnosis, followed by respiratory illnesses.

When the malnutrition status was evaluated at admission, Vermilyea et al. [6] reported that 78.7% of their patients were normal, 16.7% had moderate malnutrition, and 4.7% had severe malnutrition according to SGNA. Bagri et al. [15] observed that 42.7% of their patients were normal, 17.4% had moderate malnutrition, and 39.7% had severe malnutrition. In this study, 49.3% of our patients were normal, 18.7% moderately malnourished, and 32% severely malnourished.

It has been shown that enteral nutrition is started late in critically ill patients in PICU due to gastrointestinal dysfunction [38]. Bağci et al. [9] stated that PRISM score was found to be lower in 21.1% of their patients, who started enteral feeding within the first 6 hours of hospitalization compared to the patients who switched to enteral feeding between 7-24 hours. In this study, it was observed that parenteral nutrition was initiated frequently, especially in infected patients. The later enteral nutrition is started, the more the nutritional status of the patients is negatively affected. One of our patients with severe malnutrition that had started on parenteral nutrition switched to enteral nutrition within 1 week, and at the 4th week she was evaluated as moderately malnourished. Two of our patients with normal nutritional status at admission started on parenteral nutrition and switched to enteral nutrition within 2 weeks. These patients were diagnosed as moderately malnourished at the 4th week. Thus, present study also emphasized the importance of early enteral nutrition in PICU.

The PRISM scoring is the most common scoring system used to determine mortality [5]. Vermilyea et al. [6] reported that the mean PRISM III risk score was found to be 3.93 in normal patients and 4.41 in patients with moderate and severe malnutrition (p>0.05). Bagri et al. [15] reported a mortality rate as 36.6% in normal patients, 32.7% in moderately malnourished patients, and 43.9% in patients with severe malnutrition according to Pediatric Index of Mortality 2 scoring. In our study, the mean PRISM III score was 5.66±5.20, and 41.3% of the patients classified as normal, 29.3% moderate, and 29.3% severe. No statistically significant correlation was obtained between PRISM III score and prognosis (p>0.05). Nangalu et al. [5] observed that severe malnutrition is intrinsically associated with higher mortality even with similar PRISM score and suggested an additional score to children with WFA <60% of expected.

Vermilyea et al. [6] has reported no correlation between anthropometric measurements, biochemical parameters, and SGNA. Carniel et al. [18] demonstrated a weak correlation between SGNA and anthropometric measurements (p<0.001). Oliveira et al. [10] found a significant correlation between SGNA HFA and BMI (p<0.001, p=0.022, respectively). There was a significant statistically correlation between WFA, HFA, WFH, BMI and SGNA (p=0.001), whereas no significant correlation was observed between biochemical parameters and SGNA at admission (p>0.01) in this study.

Seremet Kurklu et al. [39] compared three different nutrition screening tools (STRONGkids, PYMS, and PNST) in inpatient children, and stated that PYMS and PNST are suitable for use in malnutrition risk assessment in pediatric inpatients due to these screening tools' high sensitivity. The PYMS revealed a relatively higher sensitivity of 90.9% and 84.6% for WFA and BMI, respectively, and PNST revealed a relatively higher sensitivity of 88.9% for HFA. Beser et al. [40] applied STRONGkids and PYMS to 1513 inpatient children and stated that no differences were identified in terms of age and sex when they analyzed the patients with increased STRONGkids and PYMS scores during discharge from the hospital. Their patients with increased scores according to both screening tools had more chronic illnesses, and their LOS was longer. In this study, only SGNA and anthropometric measurements were used.

No significant statistical difference was found between malnutrition status and biochemical parameters such as hemoglobin, albumin, CRP, and ALC in this study. It was observed that laboratory examinations did not reflect the nutritional status in critically ill children. Hemoglobin level was affected by the hydration state. Serum albumin is a negative phase reactant, and tends to decrease in admission to PICU due to increased infection process related with variable reasons. The ALC increases in cases of infection, sepsis, trauma, tissue necrosis, physical and emotional stresses [6].

It has been reported that malnutrition-associated diseases and complications are common in hospitalized patients, and LOS is significantly prolonged in these patients [41]. No significant relation has been established between LOS and malnutrition in the study of Vermilyea et al. [6], whereas Bagri et al. [15] and Beser et al. [40] reported prolonged LOS in patients with severe malnutrition. We observed statistically significant correlation between LOS and malnutrition status. The rate of severe malnutrition was significantly higher in those who were hospitalized for more than one month. A statistically significant correlation was found between the malnutrition score at hospitalization and prognosis ($p<0.05$). In severely malnourished cases, the mortality rate was found to be significantly higher.

Recently, Carter et al. [42] reported an update to SGNA and the study showed updates to the SGNA are not expected to have a significant impact on the validity of the tool and has the potential to improve its applicability to a current day practice. Since our study was conducted before this report, we do not have an oppurtunity to make a comparison.

There are some limitations in this study due to the lack of biochemical tests, limited number of cases, and single-center experience. It was not possible to obtaind the biochemical measurements of all our patients, thus it wasn´t sufficient to evaluate the correlation between SGNA and biochemical parameters.

CONCLUSION

The evaluation of nutritional status in children hospitalized in PICU is important and an early detection of malnutrition is vital for preventing a poor prognosis and prolonged LOS. In addition, SGNA is a valid method for determining malnutrition. Moreover, in this study was found a strong correlation between SGNA and anthropometric measurements, thus the application of SGNA widespread, especially in critically ill patients, can be beneficial in reducing the mortality rate in PICU.

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