Original Article

Pediatric global subjective nutritional assessment of Amazon patients newly diagnosed with acute lymphoid leukemia

Avaliação nutricional subjetiva global pediátrica de pacientes amazonenses recém-diagnosticados com leucemia linfoide aguda

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ABSTRACT

Introduction: The high prevalence of malnutrition has been reported in the pediatric oncology group since the moment of diagnosis, a fact that may be related to socioeconomic issues and metabolic effects of the cancer itself. Thus, the objective of this study was to describe the nutritional profile using the Pediatric Subjective Global Nutritional Assessment tool (ANSGP) and its possible associated factors in pediatric patients newly diagnosed with acute lymphoblastic leukemia. **Methods:** This was a cross-sectional, observational, descriptive study with a quantitative and analytical approach carried out in children and adolescents aged 2 years and 18 years recently diagnosed with acute lymphoblastic leukemia and admitted to a reference center in Amazonas, Brazil. Data collection was carried out to identify the socioeconomic, clinical and biochemical profile. The nutritional status association with nutritional statuses were then analyzed, in which patients could be well-nourished, moderately malnourished or severely malnourished. The chi-square test and Fisher's exact test were used to analyze the association. **Results:** 30 patients were included in the study. The majority of them were children <10 years old, female, and from the interior of the State (p=0.003), who did not attend school (p=0.013) due to the start of treatment (p=0.003). According to the ANSGP, the majority of girls were severely malnourished and boys were normal/well nourished (p=0.048), showing hyperphosphatemia in biochemical tests (p=0.039). The association analyzes carried out with the ANSGP classification did not result in a statistically significant difference. **Conclusion:** Pediatric Global Subjective Nutritional Assessment was able to identify a high frequency of malnutrition, becoming a promising alternative in the care of pediatric oncology patients.

RESUMO

Introdução: A alta prevalência de desnutrição tem sido relatada no grupo oncopediátrico desde o momento do diagnóstico, fato que pode estar relacionado a questões socioeconômicas e efeitos metabólicos do próprio câncer. Por isso, o objetivo desse trabalho foi descrever o perfil nutricional através da ferramenta Avaliação Nutricional Subjetiva Global Pediátrica (ANSGP) e seus possíveis fatores associados, em pacientes pediátricos recém-diagnosticados com leucemia linfoide aguda. **Método:** Este foi um estudo transversal, observacional, descritivo com abordagem quantitativa e analítica, realizada em crianças e adolescentes de 2 anos e 18 anos recém-diagnosticados com leucemia linfoide aguda e internados em um centro de referência no Amazonas, Brasil. Foram coletados dados do perfil socioeconômico, clínico e bioquímico. Então, foram analisadas as possíveis associações aos estados nutricionais bem nutrido, moderadamente desnutrido e gravemente desnutrido. O teste qui-quadrado e o teste exato de Fisher foram utilizados para analisar a associação. **Resultados:** 30 pacientes foram incluídos no estudo. A maioria eram crianças <10 anos, do sexo feminino, procedentes do interior do Estado (p=0,003), que não frequentavam a escola (p=0,013) por conta do início do tratamento (p=0,003). Segundo a ANSGP, as meninas em sua maioria encontravam-se gravemente desnutridas e os meninos eram normais/bem nutridos (p=0,048), apresentando hiperfosfatemia nos exames bioquímicos (p=0,039). As análises de associação realizadas com a classificação da ANSGP não foram estatisticamente significantes. **Conclusão:** A Avaliação Nutricional Subjetiva Global Pediátrica foi capaz de identificar elevada frequência de desnutrição, tornando-se uma alternativa promissora no cuidado de pacientes oncológicos pediátricos.

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INTRODUCTION

Leukemia can be described as a malignant hematologic disease caused by the abnormal and exacerbated multiplication of leukocyte cells, leading to their accumulation in the hematopoietic system[1]. Characterized mainly by lymphocytosis, acute lymphoid leukemia (ALL) is defined as a type of leukemia in which normal bone marrow and blood elements are replaced by immature cells of lymphoid origin, called lymphoblasts or lymphoid blasts[2–4].

In Brazil, the estimate for each year of the 2023-2025 triennium, by the José Alencar Gomes da Silva National Cancer Institute, is of 11,540 new cases of leukemia for the overall population. In Amazonas, 200 new cases of leukemia are expected annually in the state, 140 of which are to happen in Manaus, AM, Brazil[5]. Approximately 3 in every 4 cases of leukemia among children and adolescents are ALL, making this primarily a pediatric leukemia[6].

In the literature, a high prevalence of malnutrition has been reported in the pediatric oncology group since the moment of diagnosis, mainly in low and middle-income countries, a fact that may be related to socioeconomic issues and metabolic effects of the cancer itself.[7].

In patients with ALL, defining the nutritional status at diagnosis and carrying out nutritional assessment throughout treatment becomes a decisive aspect for the success of the treatment. The impact that antineoplastic therapy can have on malnutrition, whether caused by the deficit or excess of weight, appears to be decisive for the health and quality of life of these patients[8].

The "Pediatric Global Subjective Nutritional Assessment" (ANSGP) tool[9] uses a questionnaire validated in Brazil, for children and adolescents with cancer. It allows the classification of patients as well-nourished, moderately malnourished and severely malnourished. Considering the lack of studies on nutrition in oncohematology in the state of Amazonas, Brazil, this study aimed to, through the ANSGP, describe the nutritional profile and its possible associated factors in pediatric patients recently diagnosed with ALL at the Hospital Foundation of Hematology and Hemotherapy of the State of Amazonas (FHEMOAM).

METHODS

This was a prospective and descriptive study with an analytical and quantitative approach carried out from March 2023 to January 2024 at FHEMOAM, an institution located in the city of Manaus, AM, Brazil.

The sample consisted of 30 patients, respecting the following inclusion criteria: children and adolescents aged 2 to 18 years, from both genders, recently diagnosed with ALL and hospitalized for induction antineoplastic treatment. However, individuals who had previously been hospitalized at the institution or with neuropsychomotor developmental delay certified by a doctor, chronic underlying pathologies (e.g., congenital malformations, heart disease, neuropathies, liver disease, children of HIV+ mothers), impossibility of anthropometric assessment, indigenous people, patients and caregivers who did not speak Portuguese, as well as those whose guardians or patients did not agree to participate in the study were excluded.

Data collection was divided into two stages: 1) obtaining information from medical records and 2) an interview conducted by nutrition professionals who were part of the research team within the first 48 hours of the patient's hospital admission upon signing of the Free and Informed Consent Form (FICF) by parents and guardians and the Free and Informed Assent Form (FICF) by children under 12 years of age.

A form was used to record data such as gender, age, race, date of hospitalization, clinical diagnosis, type of pharmacological treatment protocol, prescribed drugs and risk group classification according to the treatment protocol, hospital unit of origin (the institution where patients remain hospitalized until transfer to FHEMOAM), and length of hospitalization in the unit of origin. The results of laboratory tests were also recorded, with the reference values for hematological and biochemical parameters being those described by the National Quality Control Program[10] and in the instructions contained in the manufacturer's leaflet for the Siemens Dimension EXL equipment.

The interview addressed socioeconomic and demographic questions such as income, education level of the patient, father and mother, type of housing, city of origin, number of people living in the household and employment status of the person responsible for the patient between 2020 and 2022. Subsequently, the ANSGP[9] tool was applied with the questions "you/your child". Thus, the tool was applied and directed to patients or their parents/guardians, covering in its composition the patient's clinical history data such as: current height/length and weight history, parents' heights, habits, and food intake (number of large meals and snacks, type of food, description of appetite, recent changes, food allergies or intolerances and usual diet).

The second part of the ANSGP consisted of questions about the frequency and duration of gastrointestinal symptoms (presence of abdominal pain, loss of appetite, nausea, vomiting, diarrhea, constipation, mucositis, odynophagia, and dysgeusia), functional capacity (school attendance, amount of energy, and sleep time), physical examination to detect signs of loss of subcutaneous fat (cheek, biceps, triceps, and ribs), muscle mass (temples, clavicle, shoulder,

scapula, thighs, and calves), and presence of edema (feet, ankles, and sacral region). At the end, the score is obtained according to the guidelines recommended by the instrument itself, classifying the nutritional status of the patient assessed as normal/well-nourished, moderately malnourished, and severely malnourished.

The anthropometric assessment consisted of measuring weight and height according to the Technical Standard of the Food and Nutrition Surveillance System (SISVAN)[11]. Weight was measured using a digital scale with a capacity of 150 kg, allowing a minimum variation of 100 g between two measurements. To measure height, a portable stadiometer was used, fixed to a level wall, allowing a maximum variation of 0.5 cm between two measurements. Nutritional status was classified according to the recommendations of the World Health Organization of 2006[12] and 2007[13] for the cutoff points of the anthropometric indices height/age (H/A) and body mass index/age (BMI/A). The data were analyzed through the Anthro[14] software for children under 5 years old and AnthroPlus[15] for children over 5 years old and adolescents.

All data were recorded in Microsoft Excel software and transferred to IBM-SPSS Statistic 29.0 software. Categorical data were presented in relative or absolute frequency. Qualitative variables were analyzed using Pearson's chi-square test or Fisher's exact test, and numerical variables were analyzed using the ANOVA test. A significance level of 95% (p-value <0.05) was considered.

The study was approved by the Research Ethics Committee (CEP) of FHEMOAM as the proposing institution under CAEE No. 65444622.8.0000.0009, observing the ethical precepts of research with human beings of the National Health Council Resolution No. 466/2012.

RESULTS

Thirty patients participated in the study, with a mean age of 7.83 years. Table 1 shows the sociodemographic and clinical characteristics. Most patients were under 10 years of age (70.0%), brown skin color (70.0%), and lived with four to seven people (63.3%). High school was the main level of education of the father and mother (30%), with a family income of up to one minimum wage (1,302.00 reais) (50%). Most patients had a guardian unemployed between 2020 and 2022 (43.3%).

The majority of boys came from the city of Manaus (85.7%) and half had not started their studies (50.0%). On the other hand, the majority of girls came from inland cities (68.8%), lived in rented homes (53.3%), were studying elementary school I (62.5%), but did not attend school ($p = 0.013$), reporting the beginning of cancer treatment as the reason for dropping out (75%) ($p = 0.003$).

The predominant diagnosis was acute lymphoblastic leukemia subtype B (96.7%), with most patients included in the high-risk group (56.7%). All patients received treatment with the Berlin-Frankfurt-Munich 2009 protocol (ALL-BFM-IC 2009).

It is highlighted in Figure 1 that patients from the interior were equally distributed in 13 municipalities of the 62 that make up the territorial composition of the State of Amazonas.

Table 1 – Sociodemographic and clinical characteristics of pediatric patients newly diagnosed with acute lymphoid leukemia (ALL) admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas, Brazil, between March 2023 and March 2024 (n=30).

Variables	Gender				Total		p-value
	Masculine		Feminine				
	n	%	n	%	n	%	
Age range							p=0.523
2-9 years and 11 months	9	64.3	12	75.0	21	70.0	
10-17 years and 11 months	5	35.7	4	25.0	9	30.0	
Total	14	100.0	16	100.0	30	100.0	
Race							p=0.105
Brown	12	85.7	9	56.3	21	70.0	
White	2	14.3	3	18.8	5	16.7	
Black	0	-	4	25.0	4	13.3	
Total	14	100.0	16	100.0	30	100.0	
City of origin							**p=0.003**
Manaus	12	85.7	5	31.3	17	56.7	
Inland cities	2	14.3	11	68.8	13	43.3	
Total	14	100.0	16	100.0	30	100.0	

Continuation Table 1 – Sociodemographic and clinical characteristics of pediatric patients newly diagnosed with acute lymphoid leukemia (ALL) admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas, Brazil, between March 2023 and March 2024 (n=30).

Variables	Gender				Total		p-value
	Masculine		Feminine				
	n	%	n	%	n	%	
Type of housing							p=0.126
Own	6	42.9	2	12.5	8	26.7	
Rented	5	35.7	11	68.8	16	53.3	
Granted	3	21.4	3	18.8	6	20.0	
Total	14	100.0	16	100.0	30	100.0	
Number of people living in the household							p=0.302
One to three	1	7.1	4	25.0	5	16.7	
Four to seven	9	64.3	10	62.5	19	63.3	
Eight to ten	4	28.6	2	12.5	6	20.0	
Total	14	100.0	16	100.0	30	100.0	
Patient's education							**p=0.020**
Didn't start studying	7	50.0	3	18.8	10	33.3	
Elementary school I	1	7.1	10	62.5	11	36.7	
Elementary school II	4	28.6	2	12.5	6	20.0	
High school	2	14.3	1	6.3	3	10.0	
Total	14	100.0	16	100.0	30	100.0	
Attend school							**p=0.013**
No	3	21.4	12	75.0	15	50.0	
Yes	4	28.6	1	6.3	5	16.7	
Didn't start studying	7	50.0	3	18.8	10	33.3	
Total	14	100.0	16	100.0	30	100.0	
Reason for not attending school							**p=0.003**
Start of treatment	3	21.4	12	75.0	15	50.0	
Didn't start studying	11	78.6	4	25.0	15	50.0	
Total	14	100.0	16	100.0	30	100.0	
Father's education							p=0.263
1st to 4th grade	1	7.1	5	31.3	6	20.0	
5th to 8th grade	2	14.3	2	12.5	4	13.3	
High school	5	35.7	4	25.0	9	30.0	
Higher education	2	14.3	2	12.5	4	13.3	
Didn't study	0	0.0	2	12.5	2	6.7	
Does not know how to inform	4	28.6	1	6.3	5	16.7	
Total	14	100.0	16	100.0	30	100.0	
Mother's education							p=0.640
1st to 4th grade	3	21.4	2	12.5	5	16.7	
5th to 8th grade	4	28.6	4	25.0	8	26.7	
High school	4	28.6	5	31.3	9	30.0	
Higher education	3	21.4	2	12.5	5	16.7	
Didn't study	0	-	2	12.5	2	6.7	
Does not know how to inform	0	-	1	6.3	1	3.3	
Total	14	100.0	16	100.0	30	100.0	

Continuation Table 1 – Sociodemographic and clinical characteristics of pediatric patients newly diagnosed with acute lymphoid leukemia (ALL) admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas, Brazil, between March 2023 and March 2024 (n=30).

Variables	Gender				Total		p-value
	Masculine		Feminine				
	n	%	n	%	n	%	
Family Income							p=0.457
Up to 1 minimum wage	6	42.9	9	56.3	15	50.0	
From 1 to 3 minimum wages	3	21.4	1	6.3	4	13.3	
No income	5	35.7	6	37.5	11	36.7	
Total	14	100.0	16	100.0	30	100.0	
Employment status of the responsible person between 2020-2022							p=0.356
He was employed and lost his job	4	28.6	4	25.0	8	26.7	
He was unemployed and got a job	2	14.3	0	-	2	6.7	
He was unemployed	6	42.9	7	43.8	13	43.3	
Been working	2	14.3	5	31.3	7	23.3	
Total	14	100.0	16	100.0	30	100.0	
Diagnosis							p=0.341
Acute lymphoblastic leukemia B	14	100.0	15	93.8	29	96.6	
Acute lymphoblastic leukemia T	0	-	1	6.3	1	3.3	
Total	14	100.0	16	100.0	30	100.0	
Risk group classification							p=0.730
Low risk	2	14.3	3	18.8	5	16.7	
Intermediate risk	3	21.4	5	31.3	8	26.7	
High risk	9	64.3	8	50.0	17	56.7	
Total	14	100.0	16	100.0	30	100.0	
Treatment protocol							p[a]
ALL-BFM-IC 2009	14	100.0	16	100.0	30	100.0	
Other	0	-	0	-	0	-	
Total	14	100.0	16	100.0	30	100.0	

n = sample size; BFM = Berlin-Frankfurt-Munich; p = Pearson's chi-square test; a = no statistics were calculated due to constant variable.

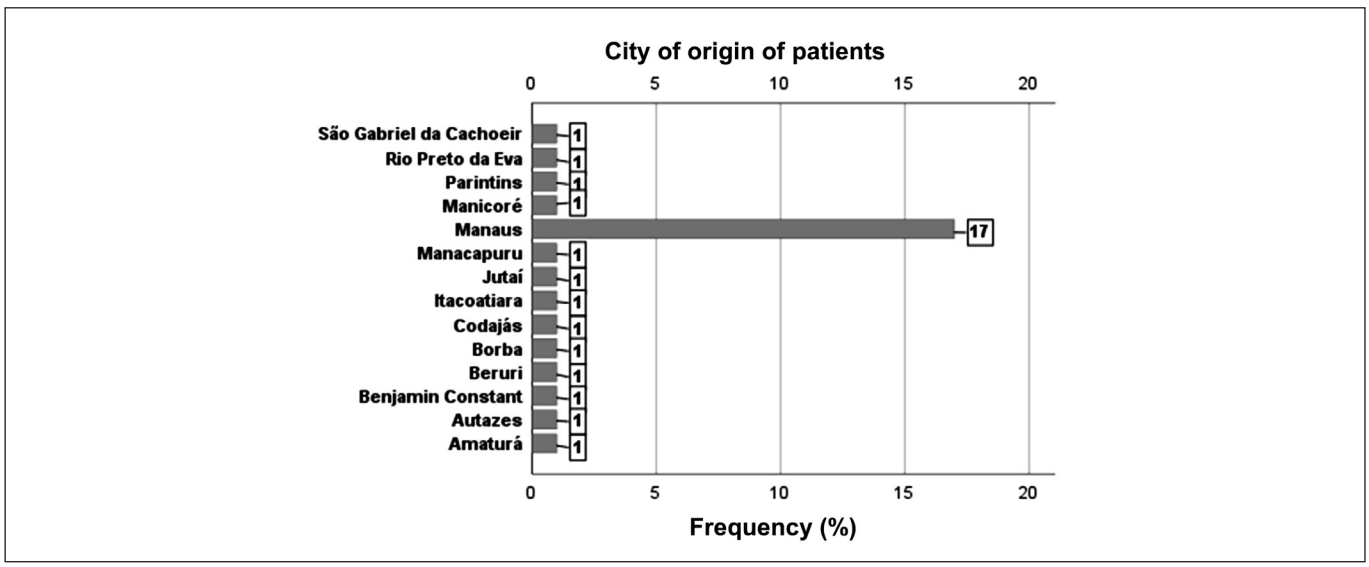

Figure 1 - *Frequency of the city of origin of pediatric patients newly diagnosed with acute lymphoid leukemia (ALL) admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas between March 2023 and March 2024 (n=30).*

The 30 participants in the study were referred from other health units, as can be seen in Table 2. The majority remained hospitalized for 8 to 14 days until they were transferred to FHEMOAM. A similar frequency (30%) was observed among individuals coming from the Children's Emergency Centre in the West and South zones.

Between the genders, there was a statistically significant difference in the classification of nutritional status by the ANSGP (p=0.048) as shown in Table 3. The majority of girls were severely malnourished (56.3%), while boys were normally/well nourished (50.0%). The majority of patients were eutrophic (73.3%) and of adequate height (86.7%), with no difference between the genders. The results of the ANSGP also indicate that the majority of patients presented signs of reduced subcutaneous fat (40%), reduced muscle mass (43.3%), and poor appetite (60%). The main gastrointestinal symptoms reported by individuals were mucositis (70%) and dysphagia (53.3%).

Regarding laboratory tests, most boys (57.1%) had phosphorus levels above 4.7 mg/dL, which were higher when

Table 2 – Hospital unit of origin and length of hospital stay of pediatric patients diagnosed with acute lymphoid leukemia (ALL) undergoing induction chemotherapy treated at the Hematology and Hemotherapy Foundation of the State of Amazonas, Brazil, between March 2023 and March 2024 (n=30).

Variables	Length of stay								Total n=30	
	Up to 7 days		8 to 14 days		15 to 21 days		22 to 30 days			
Unit of Origin	n	%	n	%	n	%	n	%	n	%
PSC East zone	0	-	4	30.8	1	20.0	0	-	5	16.7
PSC West zone	4	40.0	3	23.1	2	40.0	0	-	9	30.0
PSC South zone	2	20.0	4	30.8	2	40.0	1	50.0	9	30.0
HPS August 28th	0	-	0	-	0	-	1	50.0	1	3.3
HPS Plato Araujo	2	20.0	0	-	0	-	0	-	2	6.7
FCECON	2	20.0	0	-	0	-	0	-	2	6.7
ICAM	0	-	2	15.4	0	-	0	-	2	6.7
Total	**10**	**100.0**	**13**	**100.0**	**5**	**100.0**	**2**	**100.0**	**30**	**100.0**

n = sample size; PSC = Children's Emergency Centre; HPS = Hospital and Emergency Center; FCECON = Oncology Control Center Foundation; ICAM = Amazonas Children's Health Institute.

Table 3 – Nutritional status, physical examination, eating habits and gastrointestinal symptoms of newly diagnosed pediatric patients admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas between March 2023 and March 2024 (N=30)

Variables	Gender				Total		p-value*
	Masculine		Feminine				
	n	%	n	%	N	%	
Pediatric Subjective Global Nutritional Assessment (PGNA)							**p=0.048**
Normal/well nourished	7	50.0	3	18.8	10	33.3	
Moderately malnourished	5	35.7	4	25.0	9	30.0	
Severely malnourished	2	14.3	9	56.3	11	36.7	
Total	14	100.0	16	100.0	30	100.0	
BMI by age (0 to 18 years)							p= 0.095
Marked thinness	0	-	2	12.5	2	6.7	
Thinness	0	-	2	12.5	2	6.7	
Eutrophy	11	78.6	11	68.8	22	73.3	
Risk of overweight	0	-	1	6.3	1	3.3	
Overweight	3	21.4	0	-	3	10.0	
Total	14	100.0	16	100.0	30	100.0	

Continuation Table 3 – Nutritional status, physical examination, eating habits and gastrointestinal symptoms of newly diagnosed pediatric patients admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas between March 2023 and March 2024 (n=30)

Variables	Gender				Total		p-value*
	Masculine		Feminine				
	n	%	n	%	n	%	
Height by age (0 to 18 years)							p=0.886
Height appropriate for age	12	85.7	14	87.5	26	86.7	
Short stature for age	2	14.3	2	12.5	4	13.3	
Total	14	100.0	16	100.0	30	100.0	
Physical examination - subcutaneous fat							p=0.576
No loss	6	42.9	4	25.0	10	33.3	
Moderate loss	3	21.4	5	31.3	8	26.7	
Serious loss	5	35.7	7	43.8	12	40.0	
Total	14	100.0	16	100.0	30	100.0	
Physical exam - muscle mass							p=0.722
No loss	3	21.4	3	18.8	6	20.0	
Moderate loss	6	42.9	5	31.3	11	36.7	
Serious loss	5	35.7	8	50.0	13	43.3	
Total	14	100.0	16	100.0	30	100.0	
Appetite							p=0.587
Good	1	7.1	2	12,5	3	10.0	
Excellent	0	-	1	6,3	1	3.3	
Regular	5	35.7	3	18,8	8	26.7	
Bad	8	57.1	10	62,5	18	60.0	
Total	14	100.0	16	100,0	30	100.0	
Gastrointestinal symptoms							
Mucositis							p=0.873
No	4	28.6	5	31.3	9	30.0	
Yes	10	71.4	11	68.8	21	70.0	
Total	14	100.0	16	100.0	30	100.0	
Dysphagia							p=0.153
No	6	42.9	8	50.0	14	46.7	
Yes	8	57.1	8	50.0	16	53.3	
Total	14	100.0	16	100.0	30	100.0	
Total	**14**	**100.0**	**16**	**100.0**	**30**	**100.0**	

n = sample size; p = Pearson's chi-square test

compared to girls (p=0.039). Lower than normal red blood cell and hemoglobin values were observed in all patients (100%), while most presented thrombocytopenia (83.3%), leukopenia (50%), and elevated red blood cell distribution width (RDW) (86.7%). There also was a consistent pattern of values above the normal range of liver markers TGO (50%), TGP (40%) and alkaline phosphatase (86.7%). Normal albumin values (66.7%) and C-reactive protein (CRP) levels >3.00 mg/dL were frequently observed among patients (56.7%).

The association analyses performed between the ANSGP classification (severely malnourished, moderately malnourished and normal/well nourished) and biochemical variables (urea, phosphorus, TGO, albumin, and CRP) were not statistically significant. In Figure 2, through Fisher's exact test, when analyzing the ANSGP classification and the sociodemographic and clinical variables, we only found a statistically significant difference between the nutritional status and the gender of the patients.

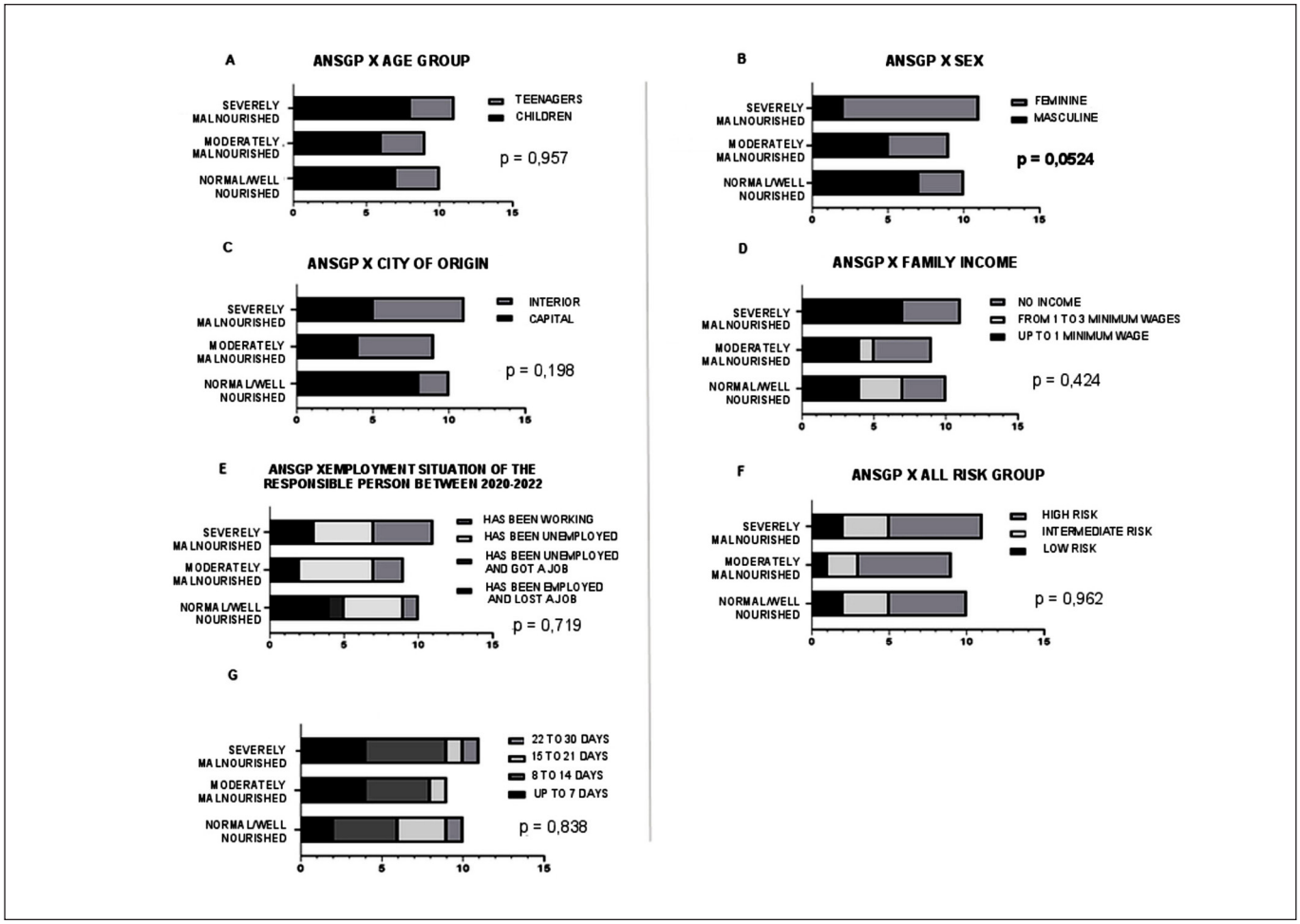

Figure 2 - *Association of the Pediatric Global Subjective Nutritional Assessment (ANSGP) with sociodemographic and clinical variables of pediatric patients newly diagnosed with ALL admitted to the Hematology and Hemotherapy Foundation of the State of Amazonas between March 2023 and March 2024 (n=30). n = sample size; p = Fisher's exact test.*

DISCUSSION

In this study, most of the patients were from the capital. However, most of the women were from the countryside, lived in rented accommodation and, although enrolled in school, had not attended the school year since the beginning of treatment. Patients from the capital benefit more from the financial resources of the metropolis and access to professionals specialized in hematological care when compared to patients from the countryside who deal with delayed diagnosis due to the low number of professionals in the area and intercity access by waterways[16]. These factors associated with the length of hospitalization and treatment may determine the change of city of residence, rented accommodation, abandonment of the school year and family economic burden.

Although this study shows that a partion of parents completed high school and that the most common family income is up to one minimum wage, most of the patients' families had no family income. During the pandemic context, between 2020 and 2022, most of the patient's parents/guardians were unemployed or employed but lost their jobs, making these patients susceptible to a situation of socioeconomic vulnerability.

Employment recovery after the COVID-19 pandemic has been a complex challenge for countries around the world. Reduced household income is one of the causes of food insecurity, where unemployment and extreme poverty can drastically reduce people's purchasing power and access to adequate and healthy food[17,18].

Children with an average age of 7.83 years, mostly brown, diagnosed with B-ALL, treated with the ALL-BFM-IC 2009 protocol and classified as high risk, composed the clinical profile of patients in this study.

When it comes to childhood cancer, B-ALL accounts for approximately 80% of all cases in children, making it the most common cancer in the pediatric age group[19], a situation observed in studies conducted in Amazonas[16], in Brazil[17] and abroad[20]. The Brazilian Institute of Geography and Statistics (IBGE)[21] confirms Amazonas as the state with the second highest proportion of brown population, while the population-based survey 20 in 47 countries in the USA

found more cases of ALL in white people. Studies conducted in Colombia[22] and India[23], with pediatric patients with ALL also treated with ALL-BFM-IC 2009, presented results contrary to this, since in both studies the majority of patients were included in the intermediate-risk group. Meanwhile, a study[24] conducted in the Brazilian semiarid region reported that in addition to GBTLI-99 being the most widely used treatment protocol, the frequency of the low-risk group was the most observed in children and adolescents with ALL.

A relevant finding in our results is that all patients evaluated were transferred from other hospital units, where most remained hospitalized between 8 and 14 days awaiting the release of beds in the referral hospital. In these units, patients also awaited confirmation of the diagnosis, often delayed due to the regulation of the hematologist's request, and began induction chemotherapy. Amazonas has the largest territorial extension of all the federative units in Brazil. However, there is only one center for the diagnosis and treatment of leukemia (FHEMOAM)[16] and currently this center only has 26 beds. According to INCA[5], the state leads the North Region. The estimate of new cases of leukemia is of 200 each year of the 2023-2025 triennium, which makes the Children's Emergency Centre in Manaus the main support units and entry points. However, they also are where waiting hospitalization can affect the patient's overall clinical condition. When evaluating the main conditions associated with longer hospitalization times for children, Magalhães et al.[25] identified that the diagnosis of hematologic disease, the presence of anemia, and low weight detected at admission were the main associated factors.

The Pediatric Subjective Global Nutritional Assessment revealed that moderate and severe malnutrition was present in 67% of patients, with the majority of women identified as severely malnourished. On the other hand, the anthropometric index BMI/A identified >70% of patients as eutrophic, with no difference between genders. In contrast to our results, the publication of the Brazilian Pediatric Oncology Nutrition Survey (IBNOPe)[26], the ANSGP identified <40% of patients as moderately and severely malnourished, with a prevalence of malnutrition in men and in children and adolescents with solid tumors, while the majority of patients assessed by BMI/A, as in our study, were also eutrophic.

Other studies[27-29] conducted with pediatric patients diagnosed with hematologic tumors found that, when using only BMI, the majority presented adequate weight. THIS suggests that malnutrition may be masked by increased fluid retention manifested as edema associated with the use of corticosteroids included in ALL treatment protocols. This could explain the difference in nutritional status classifications by ANSGP and BMI/A observed in this study. Lemos et al.[27] recommend performing other anthropometric measurements such as triceps skinfold thickness (TSF) and mid-upper arm circumference (MUAC), which diagnose malnutrition more efficiently in pediatric cancer patients. We emphasize that our results can also be clarified by the subjective methodology used in the ANSGP. Through its qualitative questions, a large part of the patient's history is collected in a succinct and rapid manner, identifying those at greater nutritional risk and require more intense nutritional monitoring, avoiding the worsening of the nutritional condition[30].

In this study, loss of subcutaneous fat and muscle mass, as well as loss of appetite and the presence of oral manifestations such as mucositis and dysphagia were identified only by the ANSGP. These symptoms, among others such as dysgeusia and xerostomia, may be the result of toxicity induced by aggressive multimodal cancer therapy, further increasing the risk of inadequate nutritional intake, dehydration, and the development of protein/calorie malnutrition[26,31–33].

The literature highlights the importance of monitoring phosphorus, since its elevated levels are one of the indicators of Tumor Lysis Syndrome (TLS), a well-recognized complication of ALL characterized by hyperuricemia, hyperkalemia, hyperphosphatemia, and hypocalcemia due to the degradation of tumor cells that occurs after the start of chemotherapy[34]. ALL is also considered the second most common cause of pancytopenia seen predominantly in the pediatric patients in this study[35].

Abnormal liver biochemistry may also occur due to leukemic infiltration or chemotherapeutic agents such as asperginase, a component of childhood ALL treatment protocols that is associated with a predominant initial elevation of serum AST and AST levels[36]. This association was not the subject of study in this study. However, it is important to highlight that asperginase is one of the chemotherapeutic agents in the BFM-2009 protocol and was administered to all patients evaluated.

Although normal albumin values have been observed in most patients, it is recognized in the literature that malnourished individuals have a deficiency of this marker due to dependence on or absence or lack of amino acids available for hepatic protein synthesis[37]. In this context, Rolim et al.[38] also recognize the usefulness of albumin in nutritional assessment. However, they emphasize that its relationship with nutritional status has limitations, as its levels can be influenced by several situations such as liver failure, kidney disease, hydration status and metabolic stress.

The nutritional status identified by the ANSGP is significantly associated with gender, but not with the patient's age group. This result differed from the IBNPe[26], in which there was an association between the ANSGP classification and age, but not between men and women. Although there was no association between our findings and other variables studied, a survey on children, cancer, and nutrition concluded that malnutrition

is correlated with low socioeconomic status, especially in countries with limited resources[39]. In another study[40], when evaluating the evolution of 38 children diagnosed with ALL, the authors highlighted that malnutrition is also associated with monthly income, access to communication, transportation, and education, and appears to affect the therapeutic response of children with ALL.

The investigation of correlations between nutritional status using subjective nutritional assessment tools is scarce in the literature, with anthropometric indicators commonly used for association studies. However, the ANSGP contains a broad and organized questionnaire that addresses not only anthropometric indices but also items on eating habits, food consumption, functional capacity, gastrointestinal symptoms, physical examination, and metabolic stress of the disease. Thus, it is important to consider subjective instruments in studies to identify factors associated with nutritional status, since, as previously discussed, anthropometric indicators can be limited when used alone in nutritional assessment.

Study Limitations

The research carried out by us is presented as one of the first investigations conducted with the ANSGP tool validated in 2017 by Saraiva et al.[9], which makes comparison with other studies that use the same tool scarce.

In addition to gender as a factor associated with nutritional status, the present study did not find statistical evidence to support the initial hypothesis that nutritional status may be influenced by nutritional, socioeconomic, clinical, and laboratory factors. This result may be due to the small sample size, which was the main limitation.

CONCLUSION

The gender of the patients was significantly associated with the nutritional status defined by the ANSGP and phosphorus levels. Severe malnutrition was seen mainly in girls, while hyperphosphatemia was observed in boys.

The ANSGP, performed in the first hours of hospitalization, was able to identify a high frequency of malnutrition in children with ALL treated at FHEMOAM. This easy-to-use tool covers not only anthropometric indicators that indicate weight and height adequacy, but also a structure of important domains to be considered in the nutritional assessment, which makes it a promising alternative in the care of pediatric oncology patients.

Brazilian studies with larger cohorts are needed, as well as research that uses the ANSGP not only during hospitalization, but also in outpatient follow-up to assess nutritional status and factors that may impact its changes during and after chemotherapy treatment.

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