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Trabajo Original

Pediatría

Patient-Generated Subjective Global Assessment of nutritional status in pediatric patients with recent cancer diagnosis

Estado nutricio en pacientes pediátricos con reciente diagnóstico de cáncer mediante la Evaluación Global Subjetiva Generada por el Paciente

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Abstract

Background: The subjective global assessment (SGA) is a simple, sensitive tool used to identify nutritional risk. It is widely used in the adult population, but there is little evidence on its effectiveness in children with cancer.

Objective: This cross-sectional study was undertaken to demonstrate significant correlation between a simplified version of the Patient-Generated SGA (PG-SGA) and anthropometric assessment to identify nutritional status in children recently diagnosed with cancer.

Methods: The nutritional status of 70 pediatric cancer patients was assessed with the PG-SGA and anthropometric measurements. The relation between the assessments was tested with ANOVA, independent samples t-test, Kappa statistic, and non-parametric Spearman and Kendall correlation coefficient. The PG-SGA divided the patients into four groups: well nourished, mildly, moderately and severely malnourished.

Results: The prevalence of malnutrition according to the PG-SGA was 21.4%. The correlations ($r \geq 0.300$, $p < 0.001$) and the concordance ($k \geq 0.327$, $p < 0.001$) between the PG-SGA and anthropometric indicators were moderate and significant.

Conclusions: The results indicate that the PG-SGA is a valid tool for assessing nutritional status in hospitalized children recently diagnosed with cancer. It is important to emphasize that the subjective assessment does not detect growth retardation, overweight or obesity.

Key words:

Nutritional status. Children. Cancer. Patient-generated subjective global assessment. Anthropometry.

Resumen

Introducción: la evaluación global subjetiva (EGS) es una herramienta sensible y simple que se utiliza para identificar el riesgo nutricional. Es ampliamente utilizada en la población adulta, pero hay poca evidencia sobre su efectividad en niños con cáncer.

Objetivo: este estudio transversal fue realizado para demostrar una correlación significativa entre una versión simplificada de la EGS generada por el paciente (EGS-GP) y la evaluación antropométrica para identificar el estado nutricio en niños con reciente diagnóstico de cáncer.

Métodos: el estado nutricio de 70 pacientes pediátricos con cáncer fue evaluado con la EGS-GP y las mediciones antropométricas. La relación entre las evaluaciones fue examinada con ANOVA, t de Student para muestras independientes, concordancia de Kappa, coeficientes de correlación no-paramétricas de Spearman y Kendall. La EGS-GP dividió a los pacientes en cuatro grupos: bien nutrido, levemente, moderadamente y gravemente desnutrido.

Resultados: la prevalencia de desnutrición de acuerdo a la EGS-GP fue 21.4%. Las correlaciones ($r \geq 0{,}300$, $p < 0{,}001$) y la concordancia ($k \geq 0{,}327$, $p < 0{,}001$) entre la EGS-GP y los indicadores antropométricos fueron moderadas y significativas.

Conclusiones: los resultados indican que la EGS-GP es una herramienta válida para la evaluación del estado nutricio en niños hospitalizados con reciente diagnóstico de cáncer. Es importante enfatizar que la evaluación subjetiva no detecta retraso en el crecimiento, sobrepeso u obesidad.

Palabras clave:

Estado nutricio. Niños. Cáncer. Evaluación global subjetiva generada por el paciente. Antropometría.

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INTRODUCTION

In the pediatric population with cancer, the frequency of malnutrition ranges between 6% and 50%, depending on the intensity of applied treatment protocols (chemotherapy and radiation therapy), food intake, and tumor types and sites (1,2).

The nutritional status of patients with cancer may deteriorate quickly during hospitalization. Children with cancer are especially at risk as disease and/or treatment can make it difficult to meet the high energy requirements for growth and development.

Furthermore, patients frequently present malabsorption, stress caused by increased acute phase response, as well as inadequate nutrient intake due to anorexia, nausea, vomiting, and alterations in taste and smell (3,4). Secondary malnutrition in children undergoing anticancer therapy includes obesity and growth retardation (5). There are growing doubts whether estimates of malnutrition based on anthropometric measurements in children alone necessarily reflect overall nutritional status and adequacy of food intake. Additionally, the correct use of growth reference data and cutoff points to determine nutritional status in children requires training among health care professionals. Nutritional assessment methods can be costly, complicated and time-consuming, and should be conducted by appropriately trained health care professionals such as dietitians, nurses, physicians or medical residents (6,7).

For early detection of patients at risk of developing malnutrition who are prone to nutrition-associated complications, the Joint Commission for Accreditation of Healthcare Organizations (JCAHO) recommends the implementation of simple nutrition screening procedures. This is especially important for children recently diagnosed with cancer (8).

The subjective global assessment (SGA) is a simple and sensitive screening tool that identifies adults at nutritional risk and offers directives for early dietary interventions.

The SGA consists of information about weight, height, food intake, gastrointestinal symptoms (loss of appetite, vomiting, diarrhea, constipation, stomach pain and nausea), functional capacity (physical activity, ability to play, hours of sleep), physical exploration, as well as the presence of ascites and edema (9).

Ottery et al. (2000) developed a patient-generated SGA (PG-SGA) for adult cancer patients that allows malnourished hospital patients to be identified and triaged for nutrition support. The components of medical history of the PG-SGA are completed by the patient, it allows for the identification of a more extensive range of nutritional impact symptoms and is suitable for use as an outcome measure in clinical nutrition practice (10).

Currently available nutritional screening tools for hospitalized children include the following: Nutrition Risk Score (NRS) (11), Pediatric Nutritional Risk Score (PNRS) (7), Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP) (12), Pediatric Yorkhill Malnutrition Score (PYMS) (13), Screening Tool for Risk of Impaired Nutritional Status and Growth (STRONGkids) (14), Pediatric Nutrition Screening Tool (PNST) (15) and the Subjective Global Nutritional Assessment (SGNA) (16). Yet it seems that no uniform approach to nutrition assessment or intervention is being employed among institutions treating children with cancer (17). The importance of using the subjective global assessment for cancer patients is that this instrument includes additional questions about cancer-related symptoms, disease type and stage and the use of steroids that may affect the nutritional status. Thus, the aim of this study was to demonstrate a significant correlation between the PG-SGA and anthropometric assessment to identify nutritional status in a pediatric population of patients recently diagnosed with cancer.

MATERIALS AND METHODS

SUBJECTS

Convenience sampling was used during a period of six months to select pediatric inpatients and outpatients aged one month to 18 years admitted consecutively for the first time to the Division of Pediatric Hematology and Oncology of the Hospital Civil de Guadalajara "Dr. Juan I. Menchaca" with suspected malignant hematological or oncologic diseases. The subjects were enrolled in a cross-sectional study before the treatment was started. The study was based on a 95% confidence level (two sided, α level: < 0.05, β level: 0.8). Using the 2010-2011 census of 82 patients seen at our pediatric oncology section, we obtained a sample size of at least 62 subjects.

Patients with a birth weight $\leq$ 2,500 g, other chronic diseases or genetic disorders were not included, and subjects in whom the diagnosis of cancer could not be confirmed were excluded. The Ethics and Research Committee of the Hospital Civil de Guadalajara "Dr. Juan I. Menchaca", as well as the Ethics, Research and Biosafety Commissions of the University Center for Health Sciences of the University of Guadalajara approved the study. Consent and assent (when applicable) of patients/their guardians were obtained. Subjective and objective evaluations were performed on the same day by the same investigator (dietitian) after training for standardized performance of objective measurements and the SGA.

SUBJECTIVE GLOBAL ASSESSMENT

The subjective assessment consisted of an adapted version of the PG-SGA with some minor modifications to simplify the instrument, and the classification of mild malnutrition was added. It was completed with information provided by the patients and parents (Fig. 1). The assessment took approximately ten minutes, and the questionnaire included the following multiple choice sections: history of weight loss in the past two weeks, changes in dietary intake during the last month (e.g., more or less than usual, mainly solid or liquid foods), nutritional symptoms (e.g., nausea, vomiting, dysgeusia, dysphagia, pain), functional capacity (e.g., normal activity, much time in bed or chair) and metabolic stress (fever). The physical examination associated with malnutrition (loss of subcutaneous fat, muscle wasting, edema) was performed according to the procedures described by Secker et al. and Martins (18,19).

Pediatric Patient Generated Subjective Global Assessment

Date of birth: **Age:** | **ID #:**

Child's name: | **Sex: F ☐ M ☐** **Date:**

A. DISEASE TYPE AND STAGE: _____ **Box A.** ☐

Scoring criteria for condition. Score is derived by adding 1 point for each of the conditions listed below that pertain to the patient.

Category A - A diagnosis in this category would be **1 point**

1. Wilm's tumor
2. Neuroblastoma
3. Metastatic solid tumors
4. Some non-Hodgkin's lymphoma
5. Acute myelogenous leukemia (newly diagnosed, relapsed)
6. Acute lymphocytic leukemia (high risk categories and relapsed)
7. Medulloblastoma and other brain tumors

Category B - A diagnosis in this category would be **0 points**

1. Good prognosis acute lymphocytic leukemia
2. Non-metastatic solid tumors
3. Advanced diseases in remission during maintenance treatment

Category C - Adding **1 point** for each condition

1. Presence of open wound
2. Medical conditions (HIV, cachexy, infection)
3. Metabolic abnormalities (Acidosis, alkalosis, hypoglycemia, hyperglycemia)
4. Organ insufficiency (renal, liver, lung, heart)
5. Post surgey (< 4 weeks ago)
6. Age < 1 year

B. WEIGHT

To determine score, use 1 month weight data if avaible. Use 6 months data only if there is no 1 month weight data. Use points below to score weight change and add one extra point if the child has lost weight during the past 2 weeks. Enter total point score in Box A

I currently weight about _____kg
I am about _____ cm tall

During the past two weeks my weight has:
☐ Not changed (0)
☐ Increased (0)
☐ Decreased (1)

	% Weight loss	
Lenght of time	**Significative**	**Severe**
One month:	**≤ 5%**	**> 5%**
Six months:	**≤ 10%**	**> 10%**
Points		

Box B. ☐

C. FOOD INTAKE

As compared to my normal intake, I would rate my food intake during the past month as:

☐ Unchanged (0)
☐ More than usual (0)
☐ Less than usual (1)
I am taking:
- ☐ Normal food, but less than normal (1)
- ☐ Little solid food (2)
- ☐ Only liquids (3)
- ☐ Only nutritional supplements (3)
- ☐ Very little of anything (4)
- ☐ Receiving tube feedings or parenteral nutrition (0)

Box C. ☐

D. SYMPTOMS

I had the following problems that kept me away from eating enough during the past two weeks (please check all that apply). The score for this section is additive

☐ No problems eating (0)
☐ No appetite, just did not feel like eating (3)
☐ Nausea (2)
☐ Constipation (1)
☐ Mouth sores (2)
☐ Foods have no taste (1)
☐ Problems swallowing (2)
☐ Pain; where? _____ (3)
☐ Other **: _____ (1)
**Examples: depression, money or dental problems

☐ Vomiting (3)
☐ Diarrhea (3)
☐ Dry mouth (1)
☐ Smells affect intake (1)
☐ Feel full quickly (1)

Box D. ☐

E. ACTIVITIES AND FUNCTION

Over the past month, I would generally rate my activity as:

☐ Normal with no limitations (0)
☐ Not my normal self, but able to be up and about with fairly normal activities (1)
☐ Not feeling up to most things, but in bed, chair or crib less than half the day (2)
☐ Able to do little activity and spend most of the day in bed, chair or crib (3)
☐ Pretty much bedridden, rarely out of bed or crib (3)

Box E. ☐

F. METABOLIC STRESS

Please check off yes or no:

I am currently on steroids or has been steroids in the past month, such as decadron, prednisone — Yes (1) ☐ No (0) ☐
I have had a fever in the past two weeks — Yes (1) ☐ No (0) ☐

Box F. ☐

(Continue in the next page)

(Cont.). Pediatric Patient Generated Subjective Global Assessment

G. PHYSICAL EXAMINATION

Physical exam includes a subjective evaluation to determine of 3 aspects of body composition (fat, muscle and fluid status) are adequate or deficit. Muscle deficit impacts point score more than fat deficit. Rating of depleted stores in these categories are not additive, therefore the highest score in either category will be the overall score.

Definition of categories: 0 = no deficit, 3 = deficit o U = unable to assess

Fat stores				Muscle stores				Fluid status				
	0	3	U		0	3	U		No edema	Mild	Moderate	Severe
Fat overlying the lower ribs				Clavicles				Ankle edema	0	1	2	3
Triceps skin fold				Shoulders (deltoids)				Sacral edema	0	1	2	3
Biceps skin fold				Scapula				Ascites	0	1	2	3
Cheeks				Quadriceps								

Box G. ☐☐☐

Global Assessment (See the global assessment categories below)

☐ Well-nourished (PGSGA-A)
☐ Mildly malnourished (PGSGA-B)
☐ Moderately malnourished (PGSGA-C)
☐ Severely malnourished (PGSGA-D)

Total score of boxes A + B + C + D + E + G = ☐
(See nutritional recommendations below)

Nutritional recommendations: Additive score of the boxes A to F is used to define specific nutritional interventions including patient & family education, symptom management including pharmacologic intervention, and appropriate nutrient intervention.

0-1 No intervention at this time. Re-assessment on routine and regular basis during treatment.

2-3 Patient and family education by a dietitian, nurse, or other clinician with pharmacological or medical nutritional therapy as indicated by current symptoms or problems.

4-8 Requires intervention by dietitian in conjunction with nurse or physician as indicated by current symptoms.

> 9 Indicates a critical need for improved symptom management and/or medical nutritional therapy.

CATEGORY	GLOBAL ASSESSMENT			
	PGSGA-A	PGSGA-B	PGSGA-C	PGSGA-D
	Well-nourished	Mildly malnourished	Moderately malnourished	Severely malnourished
Weight	No weight loss	< 5% weight loss within 1 month or < 10% weight loss within 6 months	5% weight loss within 1 month or 10% weight loss within 6 months	> 5% weight loss within 1 month or > 10% weight loss within 6 months
Nutrient intake	No change or tube feedings or parenteral nutrition	Normal food, but less than normal	Only liquids or nutritional supplements	Very little of anything
Symptoms	None or significant recent improvement allowing adequate intake	Presence of symptoms as: constipation, dry mouth, feel full quickly, food have no taste	Symptoms with nutritional impact: vomiting, diarrhea mouth sores	Presence of nutrition impact symptoms (e. g., problems swallowing, pain)
Activities and function	No limitations	Able to be up and about with fairly normal activities	Not feeling up to most things, but in bed, chair or crib less than half the day	Little activity; spend most of the day in bed, chair or crib; or rarely out of bed or crib
Physical examination	No deficit of subcutaneous fat and/or muscle mass	Evidence of mild loss of subcutaneous fat or muscle mass or muscle tone on palpation	Evidence of moderate loss of subcutaneous fat or muscle mass or muscle tone on palpation	Obvious signs of malnutrition: severe loss fat and/or muscle, possible edema

Figure 1.

Simplified version of the Patient-Generated Subjective Global Assessment.

These sections had a numerical score for each condition from zero to four depending on the impact of the symptoms on nutritional status using the check box format of the original PG-SGA. The total score of the answers is additive and provided a guide for nutritional recommendations including patient and family education, symptom management and nutritional intervention such as additional food, oral nutrition supplements, and enteral or parenteral nutrition.

For the global assessment categories of the nutritional status, patients were assigned to: well-nourished (PG-SGA A, *at least three sections rated as normal*), mildly malnourished (PG-SGA B, *at least three sections rated as mild malnutrition*), moderately malnourished (PG-SGA C, *at least three sections rated as moderate malnutrition*) and severely malnourished (PG-SGA D, *at least three sections rated as severe malnutrition*). It should be mentioned that the PG-SGA score and the subjective global rating are related, but are independent assessment and triage systems.

OBJECTIVE ASSESSMENT

Objective anthropometric assessment is considered as the gold standard in comparing the nutritional status determined by the SGA. In this study, the objective assessment included anthropometric measurements such as weight, height, and mid-upper arm circumference (MUAC); these were assessed using calibrated equipment and standardized techniques. To evaluate the nutritional status, the Z-score indexes weight/height (W/H), body mass index/age (BMI/A), height/age (H/A) and MUAC/age (MUAC/A) were calculated according to the WHO Child Growth Standards (20,21). In children older than five years, the Frisancho (22) reference was used to estimate the W/H and MUAC/A indexes. The index MUAC/A was included for children with solid tumors due to the potential influence of the tumor weight on W/H. When the Z-score was less than -1 standard deviation (SD), nutritional status was defined as mild malnutrition, moderate malnutrition was indicated by a Z-score less than -2 SD, and severe malnutrition was defined as a Z-score less than -3 SD (23). Overweight was defined by a Z-score more than +1 SD and obesity by a Z-score over +2 SD (21).

STATISTICAL ANALYSIS

Statistical analyses were performed using SPSS software version 18.0 (SPSS Inc.; New York, USA). The data presented are reported as means ± SD, unless stated otherwise. The results were considered as significant at $p < 0.05$. The independent samples t-test was used to compare the mean values of each nutritional category for both assessments. To examine the relationship among PG-SGA and individual anthropometric measurements, means of the objective measures for the four groups defined by the PG-SGA were tested with ANOVA and *post hoc* tests (Dunnett). The associations among numerical groups of the four categories defined by the PG-SGA and anthropometric indicators were tested with Spearman correlation. Kendall correlation was used to explore the relationship of the categories of the PG-SGA and the categories of the objective assessment. The agreement between the subjective and objective evaluations was assessed using the Kappa statistic. Sensitivity, specificity, and positive and negative predictive values were determined using the anthropometric indicators as the gold standard for nutritional status assessment.

RESULTS

Eighty-one children who presented suspected malignant hematological or oncologic diseases were initially enrolled in the study. However, eleven patients were excluded, as cancer diagnosis was confirmed in only 70 (36 females, 34 males). The most frequent diagnosis (58.5%) was acute lymphoblastic leukemia (ALL); 33% of all patients had small solid tumors, and 8.5% were diagnosed with either biphenotypic leukemia, acute myeloid leukemia or histiocytosis. The mean age of the subjects was 7.6 ± 5.1 years. Patients' anthropometric and PG-SGA data are shown in table I. According to the PG-SGA, 78.6% of the patients were classified as well-nourished, 17.1% were mildly malnourished and 4.3% were moderately malnourished. Based on the W/H index of the objective assessment, 62.9% were well-nourished, 18.6% mildly malnourished and 1.4% moderately malnourished. No patient was diagnosed as severely malnourished with either of the two methods. According to the BMI, six patients (8.6%) presented overweight and six (8.6%) presented obesity. The mean values of age and anthropometric indexes of each category of both nutritional assessments were compared by the independent samples t-test; and no statistical differences were observed. Overweight and obese patients were not compared because the subjective assessment does not classify children as overweight and obese.

The numerical equivalents of the PG-SGA clinical groups were moderately correlated with the Z-score means of the individual objective measurements. Significant differences ($p < 0.005$) between mean values of anthropometric indexes of each PG-SGA category were observed only between well-nourished and mildly malnourished patients (Table II), likely due to the low prevalence of moderately malnourished children ($n = 3$). Table III shows the correlations between the categories of nutritional status according the anthropometric indicators of the objective measurements and the categories of the subjective assessment. A moderate correlation ($r \geq 0.300$, $p < 0.001$) was found for all anthropometric indexes except H/A.

To examine the concordance among the PG-SGA and individual anthropometric indicators, overweight and obese patients were eliminated because the PG-SGA does not classify patients with this condition. The Kappa statistic revealed that the W/H indicator and the PG-SGA classified 41 patients as being well-nourished and eight as being malnourished. Therefore, the agreement between both evaluation methods can be described as moderate in 49 (83.1%) of 59 patients ($k = 0.560$, $p < 0.001$). In comparison with W/H, the indicators BMI and MUAC (Table III) showed a lower but significant concordance ($k = 0.478$, $p < 0.001$ and $k = 0.327$, $p < 0.001$, respectively).

Table I. Anthropometric indexes by nutritional status categories[1]

Variables	PG-SGA			Objective assessment				
	Well-nourished (n = 55) 78.60%	Mildly malnourished (n = 12) 17.10%	Moderately malnourished (n = 3) 4.30%	Well-nourished[2] (n = 44) 62.90%	Mildly malnourished[2] (n = 13) 18.60%	Moderately malnourished[2] (n = 1) 1.40%	Overweight[3] (n = 6) 8.60%	Obesity[3] (n = 6) 8.60%
Age (years)	8.1 ± 5.4	6.2 ± 3.4	13.6 ± 2.7	8.9 ± 5.4	6.7 ± 4.3	2.7 ± -	4.9 ± 4.2	7.7 ± 4.8
Weight/height (Z score)	0.4 ± 1.2	-1.0 ± 0.9	-1.2 ± 0.6	-0.0 ± 0.5	-1.4 ± 0.3	-2.2 ± -	1.3 ± 0.3	3.1 ± 0.9
Height/age (Z score)	-0.4 ± 1.1	-0.6 ± 0.8	-0.9 ± 1.3	-0.2 ± 1.1	-0.2 ± 1.2	-2.0 ± -	0.0 ± 0.8	-0.2 ± 1.1
Body mass index (Z score)	0.4 ± 1.2	-1.1 ± 1.1	-2.3 ± 0.9	-0.0 ± 0.7	-1.6 ± 0.7	-2.3 ± -	1.3 ± 0.2	2.9 ± 0.7
Mid-upper arm circumference (Z score)	0.3 ± 1.2	-1.6 ± 0.7	-2.1 ± 0.9	0.6 ± 0.8	-1.6 ± 0.7	-2.8 ± -	0.6 ± 0.9	1.0 ± 2.2

[1]X ± SD. [2]Well-nourished and malnourished patients were diagnosed according to weight/height index. [3]Overweight and obesity were diagnosed according to body mass index.

The sensitivity of the PG-SGA for screening malnutrition in our study population was regular and varied between 45.8 and 78.6% according to the anthropometric indicators; however, all indicators were highly specific (over 90%) in diagnosing well-nourished patients (Table IV).

The positive predictive values of the PG-SGA indicated that 73.3% of the patients were correctly diagnosed as malnourished. According to the indicators of the objective measurements, 76.4 to 94.5% of the patients with newly diagnosed cancer were true negatives, indicating that they were in fact well-nourished. It could be demonstrated that the PG-SGA applied in our study had good specificity and negative predictive values for diagnosing patients without malnutrition in comparison with the W/H indicator (Table IV).

DISCUSSION

For children with cancer, it is especially important to accurately assess the nutritional status from the time of diagnosis because both malnutrition and obesity can affect treatment outcome and hence, patients prognosis. The early identification of children who require a more comprehensive nutritional assessment allows for the timely implementation of an effective dietary intervention (5). Using the simplified version of the PG-SGA to assess the nutritional status of children with cancer may be advisable because it is non-invasive and can be conducted by the health care professionals (e.g., nurses, dietitians and medical residents) at the bedside yielding immediate results. An added advantage of the PG-SGA for resource-limited settings is that it does not require additional devices or supplementary examinations (24).

Few studies have reported results on the effectiveness of different subjective nutritional screening tools capable of identifying patients at risk of malnutrition. Though some studies are quite detailed and intensive (7,16), none have included pediatric cancer patients. Ottery et al. (25) published a PG-SGA for adult patients with cancer, and recently, Murphy et al. (26) published the results of an introductory study of a screening tool for childhood cancer (SCAN). But this tool was tested in a small population of children with cancer in different stages of treatment.

The present study shows that the PG-SGA is capable of identifying nutritional status in newly diagnosed pediatric cancer patients. The observed prevalence of malnutrition according to the commonly used anthropometric indexes W/H and BMI was similar to that detected by the PG-SGA (21.4%). However, MUAC classified more malnourished children (34.3%) in comparison with the PG-SGA. Our results indicated a lower prevalence of malnutrition than that reported by Ortiz-Rivera et al. (27) using BMI (36.8%) in newly diagnosed Colombian cancer patients.

According to the subjective assessment, when comparing our results with those of other studies that used different subjective assessments, the prevalence of malnutrition in our study population was similar to that referenced in children admitted to an Intensive Care Unit (21.4%) in the USA (28), but lower than those found in children scheduled for surgery (35.9%) in Thailand (29),

Table II. Relationship between the PG-SGA and anthropometric indexes[1]

Indicator	PG-SGA classification			ANOVA[2]	Spearman´s correlation[3]	
	Well-nourished (n = 55)	Mildly malnourished (n = 12)	Moderately malnourished (n = 3)	p	r_s	p
Weight/height (Z score)	*0.4 ± 1.2[a]*	*-1.0 ± 0.9[a]*	-1.2 ± 0.6	0.001	0.511	0.001
Height/age (Z score)	-0.4 ± 1.1	-0.6 ± 0.8	-0.9 ± 1.3	0.101	0.254	0.034
Body mass index (Z score)	*0.4 ± 1.2[a]*	*-1.1 ± 1.1[a]*	-2.3 ± 0.9	0.001	0.528	0.001
Mid-upper arm circumference (Z score)	*0.3 ± 1.2[a]*	*-1.6 ± 0.6[a]*	-2.1 ± 0.9	0.001	0.52	0.001

[1]X ± SD. [2]ANOVA among PG-SGA and individual anthropometric measurements. [3]Spearman's correlation between PG-SGA classification and anthropometric indexes. [a]Values in the same row with the same superscript letters are significantly different (p < 0.05) (Dunnett's T3).

Table III. Correlation and concordance between the PG-SGA and weight/height, body mass index and mid-upper arm circumference categories

Nutritional status	PG-SGA			
	Moderately malnourished	Mildly malnourished	Well-nourished	Total n (%)
Weight/height*				
Moderately malnourished	*0*	1	0	1 (1.4)
Mildly malnourished	2	*8*	3	13 (18.6)
Well-nourished	1	2	*41*	44 (62.9)
Overweight	0	1	5	6 (8.6)
Obesity	0	0	6	6 (8.6)
Total n (%)	3 (4.3)	12 (17.1)	55 (78.6)	70 (100)
Body mass index**				
Severely malnourished	1	0	0	1 (1.4)
Moderately malnourished	*0*	2	0	2 (2.9)
Mildly malnourished	2	*6*	4	12 (17.1)
Well-nourished	0	3	*40*	43 (61.4)
Overweight	0	1	5	6 (8.6)
Obesity	0	0	6	6 (8.6)
Total n (%)	3 (4.3)	12 (17.1)	55 (78.6)	70 (100)
Mid-upper arm circumference***				
Moderately malnourished	*2*	3	2	7 (10)
Mildly malnourished	0	*6*	11	17 (24.3)
Well-nourished	1	3	*35*	39 (55.7)
Overweight	0	0	5	5 (7.1)
Obesity	0	0	2	2 (2.9)
Total n (%)	*3 (4.3)*	*12 (17.1)*	*55 (78.6)*	*70 (100)*

**Kendall's tau c (r = 0.341, p < 0.001). Kappa statistics (k = 0.560, p < 0.001) were calculated without overweight and obese patients. **Kendall's tau c (r = 0.350, p < 0.001), Kappa statistics (k = 0.478, p < 0.001) were calculated without overweight and obese patients. ***Kendall's tau c (r = 0.300, p < 0.001), Kappa statistics (k = 0.327, p < 0.001) were calculated without overweight and obese patients.*

Table IV. Patient-Generated Subjective Global Assessment: sensitivity, specificity and predictive values

Indicators	Sensitivity (%)	Specificity (%)	PPV[1] (%)	NPV[2] (%)
Weight/height	78.6	92.9	73.3	94.5
Body mass index	73.3	93	73.3	93
Mid-upper arm circumference	45.8	91.3	73.3	76.4

[1]Positive predictive value. [2]Negative predictive value.

in pediatric patients prior to surgery (51%) in Canada (16) and in children from a department of pediatrics (70.7%) in Iran (30). Murphy et al. (24) reported that 49% of subjects were classified as at risk of malnutrition and 28% were considered as underweight in a study of pediatric cancer inpatients in Australia. These results were slightly higher than the results of our study.

In contrast of malnutrition, the prevalence of well-nourished children according to the PG-SGA (78.6%) was higher than the prevalence according to the objective indicators. It is important to emphasize that the subjective assessment classifies overweight and obese patients as well-nourished, in addition to patients with an adequate nutritional status. This could be the reason for an overestimation of our well-nourished patients as classified by the PG-SGA.

Numerical equivalents of the clinical groups of the subjective assessment revealed a moderate correlation with the Z-score means of the individual objective measurements. This association was higher than that found by Secker et al. (16), except to the anthropometric indicator H/A. Similarly, a moderate correlation ($r \geq 0.300$, $p < 0.001$) was found between categories of the PG-SGA and categories of the objective assessment. The k value reflected fair to moderate reliability between both evaluation methods. Concordance between the assessments in the present study was higher than that reported by Mahdavi et al. (28) ($k = 0.336$, $p < 0.001$). Considerable variability was observed among anthropometric indicators, with an agreement range of 68.3 to 83.1%.

The ideal nutrition assessment tool would be 100% specific and sensitive. In our study, the PG-SGA demonstrated a high specificity in identifying patients diagnosed as well-nourished. The specificity of our instrument was higher than that reported by Murphy et al. (26) using the new nutrition screening tool for childhood cancer (39%). Sensitivity values representing the ability of the subjective assessment to diagnose malnourished patients were good but lower than desired and referenced by Destky et al. (9) (82%), Bauer et al. (10) (75%), Mahdavi et al. (30) (88.2%) and Murphy et al. (26) (100%). This may be explained by the small sample size of subjects classified by the PG-SGA as malnourished. Despite the high specificity in our study, the sensitivity of the adapted PG-SGA was not high enough to indicate that the tool strongly predicts nutritional status as defined by anthropometric indicators.

Children with cancer are susceptible to different types of malnutrition, which may interfere with their physical and psychological development. The PG-SGA could be used by healthcare providers untrained in anthropometric assessment to quickly and easily detect malnutrition in newly pediatric cancer patients, but further modifications are needed with the attempt to improve the concordance between subjective and objective evaluations.

Simple nutritional screening procedures and the correct interpretation of data provide the basis for timely individualized nutritional counseling and intervention in pediatric patients with cancer. This is critical in helping patients to avoid complications associated with malnutrition and improve outcomes while they undergo intensive, long-lasting anticancer treatment.

Although obesity and overweight in children are increasing worldwide, and particularly in Mexico, a limiting factor of the PG-SGA is also the fact that this instrument does not include nutritional categories for overweight or obesity. The increasing number of pediatric patients with cancer who present overweight or obesity has an impact on treatment strategies and outcomes. Therefore, further studies are needed to assess the possibility of using a PG-SGA to diagnose not only patients at risk of malnutrition, but also to identify overweight and obesity as indicators of nutritional risk.

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