

SUBJECTIVE GLOBAL NUTRITIONAL ASSESSMENT: APPLICABILITY IN CHILDREN AND ADOLESCENTS WITH MALIGNANT TUMORS

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ABSTRACT

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Introduction: This study investigated the applicability of the Subjective Global Nutritional Assessment (SGNA) tool to evaluate the nutritional status of pediatric cancer patients.

Methods: This was a multicenter, observational cohort study of infants, children, and adolescents diagnosed with malignant tumors. Participants were evaluated at the moment they were diagnosed with a malignant tumor (EV1) and at the third month of treatment (EV2). Objective data were collected and the SGNA questionnaire was applied. Correlation between the methods was performed using the Kendall test.

Results: We evaluated 216 patients at EV1 and 172 patients at EV2. During EV1, 7% of patients presented with some degree of malnutrition, according to objective measures, and 35.7% according to the SGNA. During EV2, they presented 6.4% and 26.8%, respectively. The SGNA showed ability to diagnose more malnutrition than objective indicators and the agreement found between both methods was moderate and weak. We observed a significant correlation between the SGNA and the nutritional indicators ($p = <0.002$), thus proving its efficacy in assessing nutritional status.

Conclusion: The SGNA was applicable for evaluating the nutritional status of children and adolescents diagnosed with malignant tumors, and effective in tracking malnutrition prevalence when compared to objective nutritional assessment methods.

Keywords: *Tumor; Pediatrics; Nutritional status; Nutritional assessment*

INTRODUCTION

Noncommunicable diseases (NCDs) are the leading cause of morbidity and mortality worldwide. Cancer is an NCD and represents a major public health problem in both developed and developing countries¹. In Brazil, an estimated 420,000 new cancer cases were diagnosed between 2018 and 2019. For young children and adolescents, there were an estimated 12,500 new cases. According to these estimates, the southeast and northeast regions showed the highest incidence (5,300 and 2,900, respectively), followed by the midwest, with 1800 new cases, the southern region, with 1,300, and the northern region, with 1,200 new cases¹⁻³.

Malnutrition in children and adolescents undergoing cancer treatment is a poor prognostic factor. Cancer treatment itself predisposes patients to loss of appetite, increased basal metabolism, fever, and infection, which, in turn, may favor depletion of nutritional status (NS), thus delaying antineoplastic treatment and increasing the average length of hospital stay⁴⁻⁸.

Our group observed that the NS assessment protocol in pediatric cancer patients is based only on objective parameters. However, objective measures in the clinical setting are at times difficult to perform and may be biased, such as in the presence of large tumors or during periods of hyperhydration⁹. Thus, there is a need for new nutritional assessment tools that evaluate children and

adolescents diagnosed with cancer beyond objective measures to better screen for nutritional risk.

In 1987, Detsky et al.¹⁰, recommended the Subjective Global Assessment (SGA) evaluation for adults. Subsequently, in 2007, Secker & Jeejeebhoy¹¹ proposed another tool called the Subjective Global Nutritional Assessment (SGNA) for pediatric populations. This method was proven valid for evaluating children and adolescents at nutritional risk associated with postoperative complications and longer hospital stays¹¹. In 2015, Carniel et al.¹² validated this instrument for the Brazilian population, and it has since been tested in a general pediatric population at a hospital in southern Brazil. The SGNA was proven a valid and reliable method for the evaluation of NS when compared to traditional methods based only on anthropometric parameters^{11,12}. Since then, the SGNA was also tested in different pediatric subspecialties to verify its effectiveness in screening for malnutrition, similarly to the objective nutritional assessment method. The subjective evaluation has been effective in the perception of nutritional changes, working as an auxiliary method for the nutrition professional in the identification of patients who would benefit from early nutritional intervention^{13,14}. To improve knowledge of this method, the present study tested whether the SGNA could be applied to a pediatric oncology population, comparing the SGNA scores to the anthropometric parameters currently used in the clinical setting. Thus, the purpose of this study was to evaluate the applicability of the SGNA questionnaire in evaluating the NS of infants, children, and adolescents soon after the diagnosis of a malignant tumor and during 3 months of treatment.

METHODS

Study design and location

This was a multicentric, observational cohort study with primary data collection, which was conducted at the Pediatric Oncology Services of the Hospital de Clínicas de Porto Alegre, the Hospital da Criança Santo Antônio, and the Hospital da Criança Conceição in Porto Alegre, state of Rio Grande do Sul.

Population

Patients between 30 days and 18 years of age, of both sexes, who were diagnosed with malignant tumors and began treatment in either one of the 3 hospitals, were invited to participate in the study. Exclusion criteria included (1) diagnosis of recurring malignant tumors, (2) terminal illness, (3) pregnancy, (4) delayed neuropsychomotor development, (5) underlying chronic pathologies (congenital malformations, innate metabolism errors, heart disease, neuropathy, liver disease), (6) impossibility to collect anthropometric data, and (7) not being able to speak Portuguese.

Sample size

A sample of 216 patients was collected continuously from December 2016 to December 2018. The study sample size was calculated using **WINPEPI**, version 11.43. Considering a 90% statistical power, significance level of 5%, and a **-0.23** (Kendall) correlation obtained in the SGNA validation, according to Carniel et al.¹², the minimum total sample size should be 210 subjects, already accounting for 10% of losses and refusals.

Study variables

Demographic information and identification were collected from participants and their legal guardians. Weight and height measurements were performed according to the Technical Standard of the Food and Nutrition Surveillance System (Norma Técnica do Sistema de Vigilância Alimentar e Nutricional)¹⁵, with INMETRO-certified digital scales and stadiometers. Circumference and skinfolds were measured according to the Brazilian Society of Pediatrics Manual¹⁶. Arm circumference was measured with an inelastic, retractable tape measure, in millimeters; and tricipital and subscapular skinfold thickness were measured with a Lange (US) or Cescorf (Porto Alegre, Brazil) scientific plicometer. To obtain the values of upper arm muscle circumference, the formula proposed by Frisancho was employed¹⁷. The measures weight-for-age (W/A), height-for-age (H/A), weight-for-height (W/H), and body mass index-for-age (BMI/A) for children under 5 years of age were calculate using the World Health Organization (WHO) Anthro software (version 3.2.2), and the WHO Anthro Plus software (version 1.0.4), for children 5 years of age or older. The percentiles and Z-scores were interpreted according to cutoff points defined by the World Health Organization^{16,18,19}. The objective nutritional assessment was performed by analyzing the set of nutritional indicators mentioned above.

The “SGNA Questionnaire for Infants and Children Under 2 Years” and the “SGNA Questionnaire for Adolescents and Children Over 2 Years” were applied to patients and/or the parent/guardian to collect data from clinical history, weight and height history, parents’ height, food intake, and recent changes, as well as physical examination (muscle mass, subcutaneous fat, and edema). Children and adolescents were classified as well nourished, moderately malnourished, or severely malnourished. The questionnaires and the scores for each classification are attached to the instrument validation article¹².

Logistics

Data collection, and objective and subjective nutritional assessments were performed by 2 nutritionists, who were familiar with the same research study protocol. The first evaluation (EV1) was performed soon after

the diagnosis of malignant tumor in the patient's primary hospital. The second evaluation (EV2) was performed during the third month of treatment, and occurred either during hospitalization, during outpatient appointments at the patient's primary hospital, or at private clinics. Data regarding EV1 and EV2 could be collected within 15 days of the established data collection time points.

Statistical analysis

Statistical analysis was performed using the SPSS software (Statistical Package for Social Sciences), version 21.0. Quantitative variables were described by their mean and standard deviation or median and interquartile range; and the Shapiro-Wilk test was performed to assess normal distribution. Categorical variables were described by absolute and relative frequencies. To verify association between continuous variables, the Spearman correlation coefficient and the Student's *t* test for paired samples were employed. Proportions between groups were compared using Pearson's chi-square test with a prevalence ratio of 95%. The association between the assessment methods was evaluated by the Kendall rank correlation coefficient. Comparisons between the categorical variables during both time points, labelled as EV1 and EV2, were performed using the McNemar test. In all analyses, significance was established at 5%.

Ethical considerations

This study was performed according to the national ethics guidelines (NR 466/2012) of the Brazilian National Health Council²⁰. The Research Ethics Committees of each participating hospital evaluated and approved the study design (Grupo Hospitalar Conceição: approval number 1.931.294; Hospital de Clínicas de Porto Alegre: approval number 1.815.232; Hospital da Criança Santo Antônio: approval number 1.878.494). Signed informed consent was obtained by all study participants (patients or their legal guardians).

RESULTS

A total of 216 assessments were performed at the moment of diagnosis of a malignant tumor (EV1) and 172 evaluations were performed during the third month of treatment (EV2).

Most patients were aged 2-10 years and boys were more prevalent than girls in both EV1 and EV2. The most prevalent diagnosis was lymphohematopoietic neoplasms. Most patients in EV1 reported hypocaloric food intake, one or more gastrointestinal symptoms, and restriction to strenuous activities. During EV2, there were improvements in all of these conditions, but only the improvement in gastrointestinal symptoms was statistically significant ($p = 0.027$), as described in Table 1.

Table 1: Clinical and nutritional characteristics at diagnosis (EV1) and after 3 months of treatment (EV2).

| Indicators | EV1 | EV2 | <i>p</i> |
|----------------------------------|---------------|---------------|----------|
| Sample size, n | 216 | 172 | |
| Age, months | 72 [31 - 140] | 76 [37 - 146] | 0.135 |
| < 2 years | 38 (17.6%) | 26 (15.1%) | |
| 2-10 years | 118 (54.6%) | 97 (56.4%) | |
| > 10 years | 60 (27.8%) | 49 (28.5%) | |
| Sex | | | - |
| Female | 87 (40.3%) | 69 (40.1%) | |
| Male | 129 (59.7%) | 103 (59.9%) | |
| Diagnosis | | | - |
| Lymphohematopoietic neoplasms | 143 (66.2%) | 113 (65.7%) | |
| Neuroblastoma | 19 (8.8%) | 15 (8.7%) | |
| Wilms' tumor | 15 (6.9%) | 13 (7.6%) | |
| Retinoblastoma | 12 (5.6%) | 9 (5.2%) | |
| Bone tumors | 11 (5.1%) | 10 (5.8%) | |
| Other abdominal tumors | 6 (2.8%) | 5 (2.9%) | |
| Soft tissue sarcoma | 5 (2.3%) | 4 (2.3%) | |
| Germ cell tumors | 4 (1.9%) | 2 (1.2%) | |
| Nasopharyngeal tumors | 1 (0.5%) | 1 (0.6%) | |
| Food consumption | | | 0.064 |
| Adequate | 95 (44%) | 93 (54.1%) | |
| Hypocaloric | 98 (45.4%) | 59 (34.3%) | |
| Low intake | 23 (10.6%) | 20 (11.6%) | |
| Gastrointestinal symptoms | | | 0.027 |
| No symptoms | 92 (42.6%) | 98 (57%) | |
| One or more symptom, not daily | 105 (48.6%) | 67 (39%) | |
| Several symptoms, daily | 19 (8.8%) | 7 (4%) | |

Table 1: Clinical and nutritional characteristics at diagnosis (EV1) and after 3 months of treatment (EV2).

| | | | |
|---|-------------|-------------|-------|
| Functional capacity | | | 0.297 |
| No dysfunction | 87 (40.3%) | 86 (50%) | |
| Restricted | 104 (48.1%) | 66 (38.4%) | |
| Little or no activity | 25 (11.6%) | 20 (11.6%) | |
| Subcutaneous fat loss | | | 0.166 |
| No loss/mild loss | 189 (87.5%) | 151 (87.8%) | |
| Moderate loss | 20 (9.3%) | 19 (11%) | |
| Severe loss | 7 (3.2%) | 2 (1.2%) | |
| Muscle mass loss | | | 0.096 |
| No loss/mild loss | 189 (87.5%) | 150 (87.2%) | |
| Moderate loss | 19 (8.8%) | 21 (12.2%) | |
| Severe loss | 8 (3.7%) | 1 (0.6%) | |
| Edema | | | 0.500 |
| None | 215 (99.5%) | 170 (98.8%) | |
| Moderate | 1 (0.5%) | 2 (1.2%) | |
| Severe | - | - | |
| Objective nutritional assessment | | | 0.588 |
| Severely malnourished | 6 (2.8%) | 3 (1.7%) | |
| Mildly malnourished | 9 (4.2%) | 8 (4.7%) | |
| At risk for low weight | 6 (2.8%) | 9 (5.2%) | |
| Well-nourished | 116 (53.7%) | 96 (55.8%) | |
| At risk for being overweight | 30 (13.9%) | 16 (9.3%) | |
| Overweight | 26 (12%) | 21 (12.2%) | |
| Obese | 21 (9.7%) | 15 (8.7%) | |
| Severely obese | 2 (0.9%) | 4 (2.3%) | |
| Circumference and skinfolds | | | |
| AC (n = 189) | | | 1.000 |
| Adequate | 165 (87.3%) | 142 (89.9%) | |
| Below expected | 24 (12.7%) | 16 (10.1%) | |
| TST (n = 184) | | | 0.549 |
| Adequate | 165 (89.7%) | 141 (93.4%) | |
| Below expected | 19 (10.3%) | 10 (6.6%) | |
| UAMC (n = 184) | | | 0.581 |
| Adequate | 160 (87%) | 134 (89.3%) | |
| Below expected | 24 (13%) | 16 (10.7%) | |
| SST (n = 180) | | | 0.065 |
| Adequate | 164 (91.1%) | 141 (96.6%) | |
| Below expected | 16 (8.9%) | 5 (3.4%) | |
| SGNA | | | 0.426 |
| Well-nourished | 139 (64.3%) | 126 (73.2%) | |
| Moderately malnourished | 65 (30.1%) | 39 (22.7%) | |
| Severely malnourished | 12 (5.6%) | 7 (4.1%) | |

CNS: Central nervous system; SGNA: Subjective global nutritional assessment; AC: Arm circumference, adequate if percentile > 5; TST: Tricipital skinfold thickness, adequate if percentile > 15; UAMC: Upper arm muscle circumference, adequate if percentile > 5; SST: Subscapular skinfold thickness, adequate if percentile > 15. []: Data presented as median P50 (P25 – P75); (): Data presented as absolute and relative frequencies.

With regards to the physical examination, we did not observe any loss of subcutaneous fat or muscle mass and edema for most patients in both evaluations.

In relation to nutrition diagnosis, it was noted that, at the time of EV1 and EV2, most patients were well nourished, according to both objective and subjective parameters. At the time of diagnosis (EV1), 7% (n = 15) of the patients had some degree of malnutrition according to the objective nutritional assessment, and 35.7% (n = 77) according to the subjective nutritional assessment. During the third month of treatment (EV2), there was an increase

in percentiles related to perimeter and skin folds, according to the objective and subjective evaluations. At the time of EV2, 6.4% (n = 11) of patients were malnourished, according to the objective nutritional assessment and 26.8% (n = 46), according to the SGNA. The clinical and nutritional characteristics of EV1 and EV2 are described in Table 1.

Of the 216 patients included in EV1, there were 20% of losses at EV2, since 22 patients were not hospitalized and had no appointments within the stipulated time period. Eleven patients died within 3 months, 4 patients continued treatment in another

hospital, 2 patients were over 18 years old, 2 refused to attend EV2, 1 was restricted to bed, 1 had already completed treatment, and 1 patient's parents chose to interrupt treatment. Of the 172 patients remaining for EV2 evaluation, 47 had their EV1 and EV2 evaluations completed by different researchers.

To analyze the evolution of each patient's nutritional status, only the patients evaluated at both moments

(n = 172) were considered. There was an improvement in subjective and objective parameters, as shown in Table 2. According to the McNemar test and Student's *t*-test, there was no significant difference between the objective and subjective nutritional assessments comparing EV1 and EV2.

The results of the correlation analysis between the methods are described in Table 3.

Table 2: Change in nutritional status during the first 3 months after diagnosis.

| Nutritional status classification (n = 172) | EV1 | EV2 | p |
|---|---------------------------|---------------------------|--------------------|
| Anthropometric indicators | | | |
| Z-Score Weight-for-height | 0.55 ± 1.22 ^A | 0.36 ± 1.20 ^A | 0.100 ^C |
| Z-Score Weight-for-age | 0.33 ± 1.31 ^A | 0.24 ± 1.42 ^A | 0.151 ^C |
| Z-Score Height-for-age | -0.09 ± 1.17 ^A | -0.19 ± 1.18 ^A | 0.003 ^C |
| Z-Score BMI-for-age | 0.49 ± 1.34 ^A | 0.48 ± 1.46 ^A | 0.804 ^C |
| Subjective Global Nutritional Assessment | | | |
| Well-nourished | 115 (66.5%) ^B | 126 (73.2%) ^B | 0.426 ^D |
| Moderately malnourished | 49 (28.9%) ^B | 39 (22.7%) ^B | |
| Severely malnourished | 8 (4.6%) ^B | 7 (4.1%) ^B | |

BMI: Body mass index. Data are presented as absolute and relative frequencies. A: Data are presented as mean ± standard deviation; B: Data are presented as absolute and relative frequencies; *p* ≤ 0.05: denotes statistically significant results; C: Student's *t*-test; D: McNemar test.

Table 3: Correlation between data obtained from the SGNA and objective measurements.

| Indicators | N | Objective measurements | r Kendall | p |
|------------|-----|---------------------------|-----------|-----------|
| EV1 | | | | |
| W/H | 91 | 0.47 ± 1.26 ^B | -0.304** | 0.002** |
| W/A | 156 | 0.28 ± 1.34 ^B | -0.260* | 0.001* |
| H/A | 216 | 0.11 ± 1.17 ^B | -0.280* | < 0.001* |
| BMI/A | 216 | 0.51 ± 1.39 ^B | -0.287* | < 0.001* |
| AC | 180 | 19 (16-24) ^A | 0.459** | < 0.001** |
| TST | 180 | 10 (7-15) ^A | 0.249* | 0.001* |
| UAMC | 180 | 15 (13-19) ^A | 0.447** | < 0.001** |
| SST | 180 | 7 (5-10) ^A | 0.292* | < 0.001* |
| EV2 | | | | |
| W/H | 67 | 0.37 ± 1.20 ^B | -0.292* | 0.013* |
| W/A | 123 | 0.24 ± 1.42 ^B | -0.312** | < 0.001** |
| H/A | 172 | -0.19 ± 1.18 ^B | -0.162* | 0.030* |
| BMI/A | 172 | 0.48 ± 1.47 ^B | -0.197* | 0.005* |
| AC | 145 | 20 (16-24) ^A | 0.323** | < 0.001** |
| TST | 145 | 11 (8-15) ^A | -0.027 | 0.739 |
| UAMC | 145 | 16 (14-19) ^A | 0.293* | < 0.001* |
| SST | 145 | 8 (6-11) ^A | 0.061 | 0.455 |

SGNA: Subjective global nutritional assessment; W/H: Weight-for-height; W/A: Weight-for-age; H/A: Height-for-age; BMI/A: Body mass index-for-age; AC: Arm circumference; TST: Tricipital skinfold thickness; UAMC: Upper arm muscular circumference; SST: Subscapular skinfold thickness; EV1: Evaluation at the time of diagnosis; EV2: Evaluation after the third month of treatment. A: Data presented as median P50 (P25 - P75); B: Data presented as average ± standard deviation; *p* ≤ 0.05: Denotes statistically significant results. Kendall rank correlation coefficient; *: Weak correlation; **: Moderate correlation.

On average, the SGNA questionnaire was completed in 10 minutes. There was no correlation and significant difference between age and/or education level of the caregivers with regards to the time taken to answer the SGNA questionnaire, for both EV1 and EV2 evaluations.

DISCUSSION

The SGNA is a non-invasive, quick-to-apply, low-cost instrument that can be performed at the patient's bedside. This instrument was validated for the general pediatric population and showed significant correlation with the anthropometric measurements currently used for nutritional diagnosis of children and adolescents (W/H, W/A, H/A, BMI/A, AC, TST, and SST)¹². The present study indicated a moderate and weak correlation between the SGNA and other anthropometric indicators, assessed at diagnosis (EV1) and during the third month of treatment (EV2). Agreement analysis among the nutritional assessment methods was performed using the Kendall coefficient. In EV1, moderate agreement was found in W/H (9%), AC (21%), and UAMC (20%), and weak agreement was found in all other parameters. In EV2, a moderate agreement between W/A (10%) and AC (10%) was detected, whereas W/H (8%), H/A (3%), BMI/A (4%), and UAMC (8%) demonstrated weak correlations with other anthropometric indicators. In spite of these results, the SGNA remains an important tool for understanding the current nutritional assessment of pediatric cancer patients considering food intake, appetite, and weight loss, among others.

The nutrition diagnosis based on the SGNA and the objective nutritional assessment demonstrated that most patients were well nourished at EV1 and EV2. Nearly all the subjective and objective parameters were stable during EV2. The high prevalence of acute leukemia in this study may have contributed to the large number of well-nourished patients at diagnosis and during the third month of treatment, since leukemia patients present with lower risk of malnutrition, with 5 to 10% at diagnosis and 0 to 5% during treatment²¹. A large difference was found between the number of patients diagnosed with some degree of malnutrition using the SGNA assessment compared to objective methods of nutritional assessment. This may be due to the fact that the objective assessment considers only weight, height, and body mass, while the SGNA takes into consideration other parameters that influence nutritional status, such as appetite, functional capacity, and gastrointestinal symptoms.

Studies indicate a decrease in the prevalence of malnutrition, all the while with an increase in sarcopenic obesity and in overweight patients

during treatment for malignant tumors. This is associated with a higher risk of presenting minimal residual disease, toxicity associated with adiposity, and disease relapse. Reports also associate this weight gain with a gradual decrease in the release of inflammatory markers and the use of high doses of glucocorticoids²²⁻²⁵. A cohort study published in 2015 showed a decrease in the number of malnourished patients (8.3% to 4.1%) and an increase in the number of overweight patients (4.5% to 6.6%) when comparing the NS at diagnosis and during the third month of treatment, which is in agreement with the findings presented herein²⁵. Monitoring weight changes during cancer treatment may prevent cancer survivors from developing chronic diseases such as obesity, insulin resistance, dyslipidemia, hypertension, and depression, which in turn increase the risk of cardiovascular disease²⁶⁻²⁹. Strategies to identify patients at nutritional risk, whether for malnutrition or obesity, should be adopted in health services that assist pediatric cancer patients. In this regard, nutrition services, nutritional counseling, and appropriate interventions should be offered to patients and/or their caregivers^{8,22,30}.

It is known that evaluations taking into account objective nutritional measures alone may underestimate proper nutritional diagnosis. This justifies the importance of using specific nutritional assessment instruments to better characterize each population, their specific pathology and hospital environment, in addition to objective measures^{23,31}. In 2016, an adapted equivalent of the subjective nutritional assessment proposed by Secker & Jeejeebhoy¹¹ was released for use in pediatric cancer patients^{11,32}. Subsequently, another article was published with cross-cultural adaptations and instrument validations³³. The SGNA offers a better assessment of NS, since it investigates changes in body weight, food intake, gastrointestinal symptoms, and functional capacity, as well as physical changes in subcutaneous fat, muscle mass, and edema. Objective assessments alone do not contemplate these changes, which may influence NS.

The limitations found in this study were that some patients and/or guardians had difficulty answering certain questions of the assessment instrument, such as specific food intake. Because of logistics, some patients were not evaluated by the same researcher at both moments of the evaluation. This should be taken into consideration since the SGNA is a subjective evaluation method and therefore depends on the researcher's ability to collect and interpret data.

CONCLUSION

In this study, the SGNA tool proved to be adequate for assessing the nutritional status of infants, children,

and adolescents diagnosed with malignant tumors. Since it diagnosed more malnutrition than objective indicators, it seems to be effective in screening for malnutrition in this population, which is important as it allows for early nutritional intervention. Thus, further studies should be conducted to analyze the efficacy of the SGNA as a screening tool for malnutrition. This tool can be part of the routine nutritional assessment for children and adolescents with cancer and should be applied within the first hours of hospitalization, allowing for early and individualized nutritional interventions.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Note

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