ORIGINAL ARTICLE

Nutritional Risk Screening in Azorean Hospitalized Children: A Portuguese Validation Study

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Abstract

Introduction: Malnutrition risk screening identifies patients who can clinically benefit from nutritional support. STRONGkids is a malnutrition screening tool developed to identify the malnutrition risk in pediatric ages. According to the Portuguese law, at admission in a national health service hospital, it is mandatory to screen for malnutrition. In pediatric ages, STRONGkids is the recommended tool for this purpose. Although there are translations of STRONGkids into the Portuguese language, to our knowledge, there are no published studies that validate this tool for the Portuguese population. The aim of this study is to confirm the concurrent and prospective validity of STRONGkids in hospitalized pediatric children who live in Azores, Portugal.

Methodology: This cross-sectional study enabled us, for a period of five months, to collect anthropometric measures as well as to apply the STRONGkids tool to 299 hospitalized children at the pediatric ward with ages ranging between 1 and 211 months.

Results: STRONGkids scores correlated negatively with weight for height z-score of the patients (Spearman correlation -0.40, $p < 0.001$, odds ratio 0.63, 95% confidence interval 0.50-0.79, $p < 0.001$) and also with the body mass index for age z-score (Spearman correlation -0.38, $p < 0.001$, odds ratio 0.60; 95% confidence interval 0.49-0.73, $p < 0.001$). Both variables had a sensitivity and negative predictive value of, respectively, 77.2% and 95.8%, 62.1% and 98.7% to identify severely wasted children. STRONGkids also correlated positively, although weakly, with the length of stay (Spearman correlation = 0.18, $p = 0.002$; odds ratio 2.11, 95% confidence interval 1.31-3.40, $p < 0.001$). The sensitivity and negative predictive value to predict the length of stay of four days were 38.7% and 67.8%, respectively.

Discussion: This study validates the STRONGkids as a tool to identify Azorean hospitalized children who are at nutritional risk. However, future studies should validate this tool for the entire Portuguese population.

Keywords: Azores; Child, Hospitalized; Child Nutrition Disorders; Malnutrition/diagnosis; Malnutrition/epidemiology; Nutrition Assessment; Nutritional Status; Nutrition Surveys; Portugal; Risk Assessment

Introduction

Malnutrition is characterized by a nutritional deficit caused by a decreased intake, increased losses, or insufficient nutritional status due to greater catabolism induced needs Malnutrition has a negative impact on hospitalized patients, leading to a decreased immune response, increased risk of infections, difficulty in healing, decreased absorption of nutrients, and loss of muscle mass, which consequently results in an increase in the hospital length of stay and in the risk of mortality and co-morbidities.[3-6]

The prevalence of hospital malnutrition at the time of admission is 15%-70%.[4-9] Malnutrition develops and worsens in a hospital environment, but it can be largely prevented if nutritional support is an integral part of the care provided.[10]

Particularly in children, an adequate nutritional status is of the utmost importance, and malnutrition may compromise not only the course of the disease but also child growth and development.[11,12] European studies show that the prevalence of hospital child malnutrition is 6%-30%, and 44%-64% when children have an underlying disease associated with risk of malnutrition.[7,8,13-15]

Therefore, the assessment of nutritional risk, at the time

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of admission, is imperative in order to identify children at risk and who need an early intervention to reduce malnutrition in the hospital.[3,14,16]

The screening tool to assess risk on nutritional status and growth (STRONGkids), developed in 2010, is considered a simple tool, of quick application, and in accordance with the recommendations of the European Society for Clinical Nutrition and Metabolism (ESPEN), that are: assess the patient current condition, if it is stable, if the condition of the nutritional status will worsen and if the disease can accelerate nutritional deterioration.[3,17-19]

According to Portuguese law,[20] STRONGkids is the tool that should be used for screening nutritional risk in pediatric patients admitted in all national health service hospitals.[20,21] Although there are translations of STRONGkids to the Portuguese language, to our knowledge, there are no published studies that validate this tool for the Portuguese population.

The aim of this study is to confirm the concurrent and prospective validity of STRONGkids in the hospitalized pediatric children in the Azores.[3] In particular, the ability of STRONGkids to predict the z-score of weight for height (W/H) or body mass index for age (BMI/A) and height for age (H/A) at admission (concurrent validity) and hospital length of stay (prospective validity) in a mixed population of children hospitalized for both medical and surgical reasons.

Methods

Study design and sample

A cross-sectional study, with a convenience sample, was carried out in a level three hospital unit, which covers Santa Maria and São Miguel islands (about 60% of the population in the Azores archipelago).[22] The study included children older than 1 month and less than 18 years old who were hospitalized for more than 24 hours in the pediatric ward between March 2015 and July 2015. There were 308 potential participants, although after the exclusion criteria were applied, e.g. hospitalization less than 24 hours (n = 8) and an incomplete nutritional assessment (n = 1), the study ended with a sample of 299 children.

Data collection

Sociodemographic and clinical data (gender, age, admission diagnosis, admission, and discharge dates) were obtained by consulting the clinical file of each patient. The admission diagnosis was divided into three groups: infection, surgery, and others. According to the hospital length of stay, children were equally divided into two groups: children hospitalized for a period equal to or greater than the median and children hospitalized for a period less than the median, which corresponds to four days of hospitalization.

The data was collected by two trained nutritionists.

Anthropometry

Anthropometric assessment was performed on the day of admission, according to the international standards for anthropometric assessment procedures by a trained nutritionist.[23] In case of severe dehydration, the weight was only considered after correction of the hydration status.

For children aged 2 years or younger (n = 117), their weight was determined using a SECA® 354 scale (SECA, Germany) (precision 0.1 kg) with the child naked and without a diaper. For children aged more than 2 years old (n = 183), their weight was determined using a SECA® 769 scale (SECA, Germany) (precision 0.1 kg) with the child having light clothes and without shoes.

For children aged younger than 2 years old, their length was measured with the child in the supine position and determined using a baby meter SECA® 210 (SECA, Germany) (precision 5 mm). For children older than 2 years old, their height was determined using a stadiometer embedded in a scale (precision 0.1 cm), without shoes, socks, or hair ornaments while wearing light clothing or underwear. After determining the weight and height, the body mass index (BMI) was calculated.[24]

The data obtained were compared with the growth curves of World Health Organization (WHO) 2006 for children under 5 years of age and WHO 2007 for children over 5 years of age through WHO AnthroPlus® software, version 1.0.4 (WHO, Geneva, Switzerland).[1] Children were classified according to WHO definitions: severely wasted when *z*-score weight for height (from 0-60 months) or body mass index for age (from 60 months) less than -2 and severely stunted when height for age z-score < -2.[2]

Nutritional risk classification by STRONGkids

The STRONGkids malnutrition risk screening tool consists in four items or questions:

1. Presence of previous pathology or another condition associated with a high risk of malnutrition (2 points);
2. Deficient nutritional status subjectively assessed (1 point);
3) Existence of one of the following conditions: deficient nutritional intake, inability to eat due to pain, previous nutritional intervention and/or presence of vomiting and diarrhea (1 point);
4) Weight loss or no weight gain (children under 1 year old) in recent weeks/months (1 point).

The first two questions are assessed by the health professional while the other two questions are answered by the child's parents/caregivers. The total score identifies the risk of malnutrition and the need for intervention (Table 1).[3]

To test the concurrent and prospective validity of the STRONGkids - and since the number of children at high risk of malnutrition was very small - we defined a 'nutritional at risk' screening result as children who scored as moderate and high risk, and a 'nutritionally not at risk' screening result as children who were scored as low risk.

Table 1. Portuguese version of the STRONGkids risk screening tool[3]

Hospital do Divino Espírito Santo de Ponta Delgada, EPER — Accredited by CHKS Insight for better healthcare

Avaliação do Risco Nutricional na Criança / Adolescente Internado
- $STRONG_{Kids}$ Screening tool

Comissão de Alimentação e Nutrição

A- AVALIAÇÃO DO RISCO DE DESNUTRIÇÃO:			
1x/semana em crianças com idade entre 1m-18A	Score	→	Pontos
Existe uma doença prévia com risco de desnutrição (tabela B) ou previsão de grande cirurgia?	Não → 0		Sim → 2
O doente encontra-se desnutrido? (avaliação subjetiva)	Não → 0		Sim → 1
Existe alguma das seguintes condições? - diarreia excessiva (≥5x/dia) e / ou vómitos (>3x/dia) - diminuição da ingestão alimentar nos últimos dias - intervenção nutricional prévia - incapacidade de se alimentar em quantidade adequada devido a Dor	Não → 0		Sim → 1
Houve perda ponderal ou não aumento de peso (crianças < 1A) nas últimas semanas/meses?	Não → 0		Sim → 1

B- Lista de doenças previamente existentes com risco de desnutrição

- anorexia nervosa
- queimaduras
- displasia broncopulmonar (idade < 2 anos)
- doença celíaca
- fibrose quística
- prematuridade (idade corrigida: 6 meses)
- doença cardíaca crónica
- doença infeciosa (SIDA)
- doença inflamatória intestinal
- neoplasia
- doença hepática crónica
- doença renal crónica
- pancreatite
- síndrome do intestino curto
- doença muscular
- doença metabólica
- trauma
- paralisia cerebral
- previsão de grande cirurgia
- não especificado (classificado pelo médico assistente)

C- RISCO DE DESNUTRIÇÃO E NECESSIDADE DE INTERVENÇÃO:

Score	Risco	Intervenção e Follow-up
4 – 5 pontos	Alto Risco	- Consulta médica e nutricionista para avaliação clínica, diagnóstico e aconselhamento nutricional e follow-up. - Iniciar "sip feeds" até diagnóstico.
1 – 3 pontos	Médio Risco	- consultar médico para avaliação clínica e diagnóstico; considerar intervenção nutricional. - peso 2x/semana e avaliar o risco nutricional uma semana depois.
0 pontos	Baixo Risco	- não é necessária intervenção; - avaliar peso regularmente de acordo com a política do Serviço e o risco nutricional uma semana depois

Statistical analysis

Statistical analysis of the data was performed using the Statistical Package for the Social Sciences® (IBM SPSS), version 24.0 for Windows. The descriptive analysis included means, standard deviations, medians as well as absolute and relative frequencies. Chi-square test was used to compare the proportions between groups. Spearman *rho* correlation (r_s) was used to determine the correlations between continuous variables without a normal distribution. Kruskal-Wallis test for independent samples made it possible to compare the medians of continuous variables without a normal distribution. The binomial distribution test was used to compare the proportions of the groups at nutritional risk. Odds ratios (OR), which was used to compare the group 'at nutritional risk' with the group 'without nutritional risk', were calculated using logistic regression. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated considering the following conditions for each variable: weight for height *z*-score or body mass index for age ≤ 2, height for age *z*-score ≤ 2, and hospital length of stay < 4 days. A *p* value < 0.05 was considered as significant.

Results

Sample description

Table 2 describes the characteristics of the sample. According to the WHO classification, it appears that the prevalence of those who are severely stunted is higher than that of those who are severely wasted (18.1% *vs.* 11.4%). According to STRONGkids, about half of children (48.7%) are at a moderate/high risk of malnutrition (Table 3).

Table 2. Sample characterization

	Total (n = 299)
Age (months)	43.0 (9.0-127.0)
Gender	
Male	181 (60.5)
Female	118 (39.5)
Weight (kg)	15.6 (7.8-33.8)
Height (cm)	97.5 (68.1-138.8)
BMI (kg/m²)	16.8 (15.2-18.8)
***z*-score W/H (n = 164)**	0.2 (-0.9-1.0)
***z*-score W/A (n = 292)**	0.0 (-1.0-0.5)
***z*-score H/A (n = 288)**	-0.4 (-1.5-0.6)
***z*-score BMI/A (n = 287)**	0.2 (-0.8-1.0)
Acute malnutrition (*z*-score W/H < -2)	16 (9.8)
Acute malnutrition (*z*-score BMI/A < -2)	2 (1.6)
Chronic malnutrition (*z*-score H/A < -2)	52 (18.1)
Length of stay (days)	4.0 (3.0-6.0)

BMI/A - body mass index for age; H/A- height for age; W/A - weight for age; W/H - weight for height. Results are represented as n (%) or median and interquartile range (25^{th}-75^{th}).

Validation

Of our validation population, 153 children (51.2%) obtained a total of zero of a maximum of five points on the STRONGkids questionnaire, 71 (23.7%) had one of five, 42 (14%) had two of five, 21 (7%) had three of five, seven (2.3%) had four of five, and five (1.7%) obtained the maximum score.

The questionnaire divided the children into three significantly different risk groups ($p \leq 0.001$): 153 (51.2%) of the children were categorized as low nutritional risk, 134 (44.7%) as moderate risk, and 12 (4%) children were considered at high nutritional risk. In other words, 51.2% of hospitalized children were not at nutritional risk, while 48.7% were at nutritional risk.

Table 4 shows an overview of the STRONGkids risk scores. Distribution of the age and diagnostic categories were statistically significant among the different risk groups ($p = 0.011$ and $p < 0.001$, respectively). The median and interquartile range (IQR) age of children in the low-risk group of 66.0 months (IQR 16.0-135.0) was significantly higher ($p = 0.02$) than the group of children with moderate risk with 25 months (IQR 5.0-113.0). However, there are no significant differences between the median of the high-risk group with 31 months (IQR 15.0-56.5) and the low and moderate risk groups ($p = 0.14$ and $p = 0.76$, respectively). There was a negative and statistically significant correlation, although weak, between age and the risk category ($r_s = -0.12$, $p = 0.04$). The percentage of children suffering from an underlying disease increases significantly ($p < 0.001$) with each nutritional risk level: 0% in the low-risk group, 26.9% in the moderate-risk group and 100% in the high-risk group.

Concurrent validity

The results of concurrent validity are shown in Table 5. The weight for height *z*-score correlates negatively ($r_s = -0.40$) and significantly ($p < 0.001$) with the STRONGkids nutritional risk categories. According to Table 3, the median of the weight for height *z*-score in the low-risk group was 0.7 (IQR -0.1-1.5), which was significantly higher ($p = 0.001$) than that of the moderate and high-risk groups of -0.1 [-1.0-(-0.7)] and -2.2 [-2.6-(-0.7)], respectively. There are also significant differences between the medians of the moderate and high-risk groups ($p = 0.005$). According to Table 6, five (31.3%) of the children, under the age of 60 months, identified

with severely wasted were classified in the high-risk group, eight (50.0%) were classified as moderate-risk and three (18.8%) classified as high-risk category. The odds ratio of children at nutritional risk against children without nutritional risk for being severely wasted, in children under 60 months of age, was 0.63 with a 95% confidence interval (95% CI) 0.50-0.79 times higher compared with children with weight for height *z*-score greater than -2 ($p < 0.001$). STRONGkids has a sensitivity of 77.2% and specificity of 48.6%, a positive predictive value of 14.1%, and a negative predictive value of 95.8% for detecting severely wasted children younger than 60 months of age.

The body mass index for age *z*-score correlates negatively ($r_s = -0.38$) and significantly ($p < 0.001$) with the STRONGkids categories. According to Table 3, the median body mass index for age z-score in the low-risk group was 0.6 (IQR -0.1-1.3), which was significantly higher ($p = 0.001$) than that of the moderate and high-risk groups with -0.2 (IQR -1.1-0.6) and -1.8 [IQR -2.3-(-1.1)], respectively. There are also significant differences between the medians of the moderate and high-risk groups ($p < 0.001$). According to Table 6, one (50%) of the children, aged over 60 months, identified as severely wasted was classified in the group of moderate nutritional risk and one (50%) classified as low risk. The odds ratio of children at nutritional risk against children without nutritional risk for being severely wasted, in children over 60 months of age, was 0.60 (95% CI 0.49-0.73) times higher compared to children with a body mass index for age z-score greater than -2 ($p < 0.001$). STRONGkids has a sensitivity of 62.1% and specificity of 70.1%, a positive predictive value of 2.1% and a negative predictive value of 98.7% to detect children severely wasted and over 60 months of age.

The height for age *z*-score correlates negatively ($r_s = -0.22$) and significantly ($p < 0.001$) with the STRONGkids categories. According to Table 3, the median height for age *z*-score in the low-risk group was -0.2 (IQR -1.1-0.6), which is significantly higher ($p < 0.001$) than that of the high-risk group with -3.7 [IQR-4.3-(-3.1)]. The median height for age *z*-score in the group with moderate-risk was -0.5 (IQR -1.7-0.5), which was significantly higher ($p < 0.001$) than that of the group with high nutritional risk. However, there are no significant differences between the medians of the low and moderate-risk groups ($p = 0.092$). According to Table 6, nine (17.3%) children identified as severely stunted were classified in the group with high nutritional risk, 28 (53.8%) were classified as moderate-risk and 15 (28.8%) classified as high-risk. The odds ratio of children at nutritional risk against children without nutritional risk for severely stunted children was 0.92 (95% CI 0.78-1.08) compared with children with a higher height for age *z*-score > -2. However, this value is not significant ($p = 0.303$). STRONGkids has a sensitivity of 49.6% and specificity of 63.9%, a positive predictive value of 26.2% and a negative predictive value of 89.8% to detect children severely stunted.

Table 3. Sample characterization, according to the score obtained through STRONGkids

	Low risk (n = 153)	Moderate risk (n = 134)	High risk (n = 12)	*p* value
Age (months)	66.0 (16.0-135.0)	25.0 (5.0-113.0)	31.0 (15.0-56.5)	< 0.001*
Gender				
Male	100 (65.4)	74 (55.2)	7 (58.3)	
Female	53 (34.6)	60 (44.8)	5 (41.7)	0.213
Weight (Kg)	21.3 (10.5-39.1)	11.5 (6.1-27.5)	7.8 (7.5-10.1)	< 0.001*
Height (cm)	106.0 (78.0-142.5)	86.0 (62.5-128.5	74.0 (68.0-83.0)	< 0.02*
BMI (kg/m²)	17.7 (16.1-20.2)	16.1 (14.6-17.6)	13.6 (12.3-15.7)	< 0.001*
***z*-score W/H (n = 164)**	0.7 (-0.1-1.5)	-0.1 (-1.0-0.7)	-2.2 [-2.6-(-0.7)]	< 0.001*
***z*-score W/A (n = 292)**	0.0 (-0.3-0.8)	-0.3 (-1.4-0.2)	-3.7 [-3.9-(-2.1)]	< 0.001*
***z*-score H/A (n = 288)**	-0.2 (-1.1-0.6)	-0.5 (-1.7-0.5)	-3.7 [-4.3-(-3.1)]	< 0.001*
***z*-score BMI/A (n = 287)**	0.6 (-0.1-1.3)	-0.2 (-1.1-0.6)	-1.8 [-2.3-(-1.1)]	< 0.001*
Acute malnutrition (*z*-score W/H < -2)	3 (4.2)	8 (9.6)	5 (55.6)	< 0.001*
Acute malnutrition (*z*-score BMI/A < -2)	1 (1.3)	1 (2.1)	0 (0)	0.937
Chronic malnutrition (*z*-score H/A < -2)	15 (10.2)	28 (21.4)	9 (90.0)	< 0.001*
Length of stay (days)	3.0 (2.0-6.0)	4.0 (3.0-7.0)	6.0 (3.5-13.0)	< 0.001*

BMI/A - body mass index for age; H/A- height for age; W/A - weight for age; W/H - weight for height.
* Significant for $p < 0.05$.
Results are represented as n (%) or median and interquartile range (25^{th}-75^{th}).

Prospective validity

The results of the prospective validity are presented in Table 5. The median hospital length of stay for children at low-risk was 3 days (IQR 2.0-6.0), 4 days (IQR 3.0-7.0) for the moderate-risk group and 6 days (IQR 3.5-13.0) for the high-risk group" (Table 3). The median hospital length of stay between the low and moderate-risk group was significantly different ($p < 0.001$). There is a positive ($r_s = 0.18$) and significant ($p = 0.002$) correlation between the hospital length of stay and STRONGkids categories. The odds ratio of children at nutritional risk against children without nutritional risk for a period equal to or greater than four days was 2.11 times (95% CI 1.31-3.40) higher compared to children hospitalized for less than four days ($p = 0.002$). STRONGkids has a sensitivity of 38.7% and specificity of 74%, a positive predictive value of 50%, and a negative predictive value of 67.8% to detect children at risk for longer hospitalization than the median.

Discussion

As the instrument for assessing the risk of malnutrition in pediatric age, STRONGkids is the regulated tool for use in hospital health units in Portugal. However, we did not find a published methodological description for its prospective and concurrent validation among the Portuguese population.

This study aimed to validate the referred tool in the Azorean hospitalized pediatric population, and we confirmed that STRONGkids can predict malnutrition through the *z*-score of the WHO growth charts, in particular the ability to predict the *z*-score of weight for height, body mass index for age and height for age at admission (concurrent validity), and the hospital length of stay (prospective validity).

All children admitted to the pediatric ward of the hospital unit on São Miguel Island were evaluated for a period of five months. It was observed that 11.4% of the children were severely wasted and 18.1% were severely stunted, based on the WHO definition.[2] According to the score obtained through STRONGkids, 44.7% of the children were classified as moderate risk and 4% as high nutritional risk. These results are similar to those obtained by other authors among 368 children from 29 pediatric hospitals, in which 47.3% had a low risk of malnutrition, 45.1% a moderate risk, and 7.6% a high risk.[16] In research on the assessment of the risk of malnutrition in 90 hospitalized children in the same hospital unit as this study, and through the application of the same nutritional risk identification tool, the results were 47.8% children with a moderate risk of malnutrition and 2.2% with a high risk.[7] Also in a multicentric study of Portuguese hospital units with 419 children admitted to pediatric wards in Portuguese hospitals, it was found, with the same tool, that 58.2% of the patients were at risk of moderate or high malnutrition[25], as well other authors who observed in 63 children in a hospital unit, 58.7% had a moderate risk and 3.2% a high risk of malnutrition.[8]

As shown in other studies as well as this study, it was found that children at nutritional risk (classified as moderate or high risk) have weight for height, body mass index for age,

Table 4. Overview of the STRONGkids risk scores

Nutritional risk	Total (n = 299)	Low risk (n = 153)	Moderate risk (n = 134)	High risk (n = 12)	*p* value
General	299 (100)	153 (51.2)	134 (44.7)	12 (4)	< 0.001*
Age					
0-12 months	83 (27.8)	32 (20.9)	49 (36.6)	2 (16.7)	
12-24 months	34 (11.4)	14 (9.2)	18 (12.4)	2 (16.7)	
24-120 months	103 (34.4)	60 (39.2)	36 (26.9)	7 (58.3)	
> 120 months	79 (26.4)	47 (30.7)	31 (23.1)	1 (8.3)	0.011*
Underlying disease					
Yes	48 (16.1)	0 (0)	36 (26.9)	12 (100)	
No	251 (83.9)	153 (100)	98 (73.1)	0 (0)	< 0.001*
Diagnostic category					
Infection	135 (45.2)	67 (43.8)	66 (49.3)	2 (16.7)	
Surgery	54 (18.1)	43 (28.1)	10 (7.5)	1 (8.3)	
Other	110 (36.8)	43 (28.1)	58 (43.3)	9 (75)	< 0.001*

* Significant for $p < 0.05$.
Results are represented as n (%).

and height for age *z*-scores significantly lower, a higher prevalence of malnutrition, and longer hospital length of stay when compared to children without nutritional risk, who are classified as low risk.[3,26] In opposition to the results obtained by other authors, in this study, the correlation between the STRONGkids score and the body mass index for age *z*-score was stronger than the correlation between STRONGkids and the height for age *z*-score (r_s = -0.38 and r_s = -0.22, respectively).[26]

The Azorean pediatric population evaluated in this study had a prevalence of 11.4% of severely wasted children at admission, which seems to be consistent with the results of other studies carried out in developed countries.[3,7,16,19,26] Positive predictive value and negative predictive value obtained for the variables weight for height *z*-score (14.1% and 95.8%, respectively) and body mass index for age (2.1% and 98.7%, respectively) are identical to the values described in the validation study of the STRONGkids carried out in a Belgian population.[16] These values show that, in a population with an 11.4% prevalence of severely wasted children, there would be an approximately 5% probability of children classified as low risk by STRONGkids actually being severely wasted. Since, in this study, this population had a prevalence of severely stunted children of 18.1%, children with low risk will have a 10% probability of being severely stunted and 13% probability of having a hospital length of stay of more than four days.

The presence of a previous underlying disease has an influence on the STRONGkids score, directly classifying it as having at least moderate risk.[7,26] Therefore, all children with an underlying disease (16.1% of the sample) presented a moderate/high risk of malnutrition. From the children admitted with underlying disease, 48.8% were severely stunted, 38.1% were severely wasted, and the remaining had an adequate nutritional status. These values are in accordance with other authors and based on the WHO malnutrition classifications that refer to a higher prevalence of severely wasted children with an underlying disease.[27]

Another variable that proved to be determinant in the nutritional risk of the Azorean pediatric population was the child's age. We found a negative and, although weak, significant correlation between age and the nutritional risk categories (p = 0.04, r_s = -0.12). The same result was also found in other studies.[19,26]

The main aim of a nutritional risk screening tool is to prevent children who are initially screened as having no nutritional risk, and who are not fully assessed on their nutritional status, should effectively be at risk of malnutrition or already malnourished. As such, the specificity of a nutritional screening tool becomes less important because a false positive result will only expose the child to a complete nutritional assessment, while a false negative result can lead to failure to recognize malnutrition.[16] In this study, the variables weight for height z-score and body mass index for age, used in the definition of severely wasted children by the WHO, proved to be the most sensitive in detecting children at nutritional risk (77.2% and 62.1%, respectively). Any of the analyzed variables have a low positive predictive value and a high negative predictive value, which confirms the ability of this tool to identify most of well-nourished children as being not at nutritional risk, but it may categorize some of the well-nourished children as being at nutritional risk. The results obtained in the diagnostic tests of this study match with the results of other validation studies of the same tool that were carried out in other developed countries.[3,16,19,26,28]

In a hospital environment, it is important not only to identify malnourished children but also those children who are at risk of malnutrition. Therefore, an appropriate tool should be used according to the ESPEN recommendations and those of other authors, which should be practical as well as quickly and simultaneously objective and subjective.[14,17,29]. The STRONGkids tool fulfils all of these requirements, but it is important to take into account that it has some limitations, such as the fact that the total score is influenced by underlying diseases that are already associated with an increased risk of malnutrition only when they are in their 'active' state. Taking this into consideration, an important change to implement in STRONGkids would be to make it a tool capable of distinguishing wasted from stunted clinical conditions.[3,7,16,26]

We consider that the present study is relevant because it is a prospective and concurrent validation of the STRONGkids in the Azorean hospitalized pediatric population. On the other hand, the fact that it is a study carried out in a single hospital, makes it impossible to validate STRONGkids for the Portuguese pediatric population. Its cross-sectional design also does not allow a longitudinal analysis of nutritional changes over time, which makes it difficult to confirm whether children well-nourished on admission, but whose STRONGkids classified has a high risk of malnutrition (5.7% of the sample), developed malnutrition over time.

Given the significant variations in anthropometric measurements that occur in hospitalized children, it is essential to assess the impact that these variations may have on the risk of malnutrition. STRONGkids is a validated tool, which from a legal point, should already be routinely used in Portugal. However, its statistical validation has not yet been carried out in these country, so we consider that,

Table 5. Concurrent and prospective validity of STRONGkids

	Spearman *rho*	Sensibility (%)	Specificity (%)	PPV (%)	NPV (%)	OR (95% CI)
Concurrent Validity						
***z*-score W/H**	-0.40*	77.2	48.6	14.1	95.8	0.63 (0.50-0.79)*
***z*-score IMC/A**	-0.38*	62.1	70.1	2.1	98.7	0.60 (0.49-0.73)*
***z*-score H/A**	-0.22*	49.6	63.9	26.2	89.8	0.92 (0.78-1.08)
Prospective validity Length of stay	0.18⁺	38.7	74.0	50.0	67.8	2.11 (1.31-3.40)⁺

BMI/A - body mass index for age; H/A- height for age; OR - odds ratio; VPN - negative predictive value; VPP - positive predictive value; W/A - weight for age; W/H - weight for height.
* Significant for $p < 0.001$.
⁺ Significant for $p < 0.05$.

Table 6. Severely wasted and severely stunted children according to the classification of nutritional risk obtained through STRONGkids

Nutritional risk	Low risk n (%)	Moderate risk n (%)	High risk n (%)	*p* value
Severely wasted (*z*-score W/H)	3 (18.8)	8 (50.0)	5 (31.3)	< 0.001*
Severely wasted (*z*-score BMI/A)	1 (50.0)	1 (50.0)	0 (0)	0.937
Severely stunted (*z*-score H/A)	15 (28.8)	28 (53.8)	9 (17.3)	< 0.001*
Malnutrition (wasted + stunted)	0 (0)	2 (28.6)	5 (71.4)	< 0.001*

BMI/A - body mass index for age; H/A- height for age; W/H - weight for height.
* Significant for $p < 0.05$.

at this moment, this validation procedure is fundamental. For that, future studies, with a larger number of patients and centers, should validate STRONGkids for the entire Portuguese hospitalized pediatric population.

To assure the use of this tool, it would also be interesting to evaluate its implementation and use in national hospitals.

Malnutrition has an adverse effect on hospitalized children and malnutrition risk should be routinely assessed at hospital admission in pediatric patients to provide an early nutritional intervention.

STRONGkids is a simple, quick, and easy to use instrument to assess malnutrition risk, but to our knowledge, there are no published studies that validate this tool for the Portuguese hospitalized pediatric population.

The statistical analysis of the present study allowed the validation STRONGkids to predict malnutrition and the hospital length of stay in our pediatric hospitalized population.

WHAT THIS STUDY ADDS

- Malnutrition has an adverse effect on hospitalized patients and, therefore, malnutrition risk should be routinely assessed.
- According to the Portuguese legislation, at hospital admission, malnutrition risk screening is mandatory. In pediatric settings, as a screening tool to assess risk on nutritional status and growth, STRONGkids is recommended.
- To our knowledge, this is the first Portuguese pediatric population study for STRONGkids validation.
- STRONGkids significantly correlated with the z-score of the WHO growth charts and hospital length of stay.
- The statistical analysis of the present study allowed the validation STRONGkids to predict malnutrition and the hospital length of stay in our Portuguese pediatric hospitalized population.

Conflicts of Interest

The authors declare that there were no conflicts of interest in conducting this work.

Funding Sources

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Protection of human and animal subjects

The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Provenance and peer review

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Confidentiality of data

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

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Rastreio de Risco Nutricional em Crianças Açorianas Hospitalizadas: Estudo de Validação Português

Introdução: O rastreio de risco de desnutrição identifica doentes que beneficiam clinicamente de suporte nutricional. O STRONGkids é uma ferramenta de identificação de risco nutricional desenvolvida para identificar o risco de desnutrição em idade pediátrica. De acordo com a lei portuguesa, no momento de admissão num hospital do serviço nacional de saúde, é obrigatório o rastreio de desnutrição. Na idade pediátrica, o STRONGkids é a ferramenta recomendada para esse fim. Embora existam traduções do STRONGkids para a língua portuguesa, do nosso conhecimento, não existem estudos publicados que validem esta ferramenta para a população portuguesa. O objetivo deste estudo é confirmar a validade concorrente e prospetiva do STRONGkids nas crianças hospitalizadas residentes nas ilhas dos Açores, em Portugal.

Métodos: Este estudo transversal permitiu, por um período de cinco meses, recolher medidas antropométricas e aplicar o instrumento STRONGkids em 299 crianças hospitalizadas na enfermaria pediátrica, com idades entre 1-211 meses.

Resultados: As pontuações do STRONGkids apresentaram uma correlação negativa com o *z-score* do peso para a altura dos doentes (correlação de Spearman -0,40, $p < 0,001$, *odds ratio* 0,63, intervalo de confiança 95% 0,50-0,79, $p < 0,001$) e também com o *z-score* índice de massa corporal para a idade (correlação de Spearman -0,38, $p < 0,001$, *odds ratio* 0,60, intervalo de confiança 95% 0,49-0,73, $p < 0,001$). Ambas as variáveis tiveram uma sensibilidade e valor preditivo negativo de, respetivamente, 77,2% e 95,8%, 62,1% e 98,7% para identificar crianças gravemente desnutridas. A pontuação do STRONGkids também se correlacionou positivamente, embora fracamente, com o tempo de internamento (correlação de Spearman 0,18, $p = 0,002$, *odds ratio* 2,11, intervalo de confiança 95% 1,31-3,40, $p < 0,001$). A sensibilidade e o valor preditivo negativo para prever um tempo de internamento de quatro dias foram, respetivamente, 38,7% e 67,8%.

Discussão: Este estudo valida o STRONGkids como ferramenta para identificar crianças açorianas hospitalizadas em risco nutricional. No entanto, estudos futuros deverão validar esta ferramenta para toda a população portuguesa.

Palavras-Chave: Açores; Avaliação Nutricional; Avaliação de Risco; Criança Hospitalizada; Desnutrição/diagnóstico; Desnutrição/epidemiologia; Estado Nutricional; Inquéritos Nutricionais; Portugal; Perturbações da Nutrição Infantil