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CLINICAL RESEARCH

STRONGkids nutrition screening tool in pediatrics: An analysis of cutoff points in Brazil

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Abstract

Background: Studies have indicated the Screening Tool for Risk on Nutritional Status and Growth (STRONGkids) as a method of pediatric nutrition screening with good validity in the hospital setting. However, we need to analyze whether the cutoff values originally proposed are suitable for use in Brazil.

Methods: A cross-sectional study was performed in patients admitted to the pediatric ward of a public hospital. STRONGkids was used to assess nutrition risk (low risk, 0 points; moderate risk, 1–3 points; and high risk, 4–5 points). The indexes weight/height or body mass index/age were used to indicate acute malnutrition, and length or height/age was used to indicate chronic malnutrition. Receiver operating characteristic curves were constructed and the areas under the curve were calculated, with respective 95% confidence intervals, to assess the ability of STRONGkids to predict malnutrition and longer hospital stay.

Results: The study included 599 patients, with a median age of 2.6 years. The frequency of nutrition risk (medium or high) was 83.6%. In comparison with anthropometric indexes, STRONGkids was the only scoring system with the discriminatory capacity to identify patients with longer hospital stays. The comparative analysis of the means of hospital stay according to STRONGkids showed that patients with a score equal to 3 behaved similarly to those classified as high nutrition risk (4–5 points).

Conclusions: Considering the best cutoff point to predict prolonged hospitalization, STRONGkids used in Brazil should consider patients with 3 points as having high nutrition risk, as well those scoring 4 and 5.

KEYWORDS
hospital length of stay, malnutrition, nutrition screening, pediatric

1 | INTRODUCTION

Malnutrition is a disease of clinical and social nature. It can be characterized as a condition resulting from the lack of or inadequate intake of energy and nutrients to meet the individual needs of an organism (primary malnutrition) or from factors that interfere with the nutrients' utilization, conditions that promote excessive loss of nutrients (diarrhea, renal insufficiency, bleeding, among others), or an increase in energy expenditure that is associated with diseases (secondary malnutrition).[1–3]

Pediatric malnutrition is a multifactorial condition defined as an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein, or micronutrients. It can be classified as non–illness related (caused by environmental or behavioral factors), illness related (secondary to one or more disease or injury), or both. In illness-related malnutrition, the presence of an acute or chronic condition can increase the requirement for nutrients (hypermetabolic conditions), increase nutrient losses (eg, chronic diarrhea, burns, proteinuria), and modify nutrient utilization (malabsorption states), affecting growth, development, and health.[1]

The development of this condition is frequent in a hospital setting and is potentiated in children and adolescents because of the increase in energy requirements for the process of growth and the impact of the condition on the nutrition status, such as decreased appetite caused by medicines and clinical condition and neglected diet during the treatment of disease.[4] Recently, studies have shown a reduction in malnutrition rates in Brazil[5,6]; however, in the hospital context, this condition has become increasingly prevalent.

Malnutrition is a serious condition in hospitalized pediatric patients and a risk factor for complications that contribute to a poor prognosis because it is associated with an increased risk of infections, postoperative complications, reduced muscle mass, impaired wound healing, and increased morbidity and mortality. Malnutrition also contributes to longer hospital stays and increased health-care costs.[7,8] International studies show malnutrition rates between 19% and 45.6% in hospitalized children. In Brazil, pediatric hospital malnutrition rates range from 7.5% to 58%.[2,7]

In this regard, nutrition screening is of primary importance for early detection of individuals at risk of malnutrition. These individuals need a complete nutrition assessment and interventions to prevent the development of nutrition deficits and their consequences.[7] The implementation of nutrition screening tools in hospitals has been widely recommended owing to the high prevalence of malnutrition in pediatrics[3] because they allow for the increased adequacy of treatment, which can induce a better prognosis in patients.[2] Currently, several methods of nutrition screening are described in the literature. However, the existence of factors that interfere with their diagnostic accuracy justifies the need to analyze their effectiveness in contexts different from those in which the methods were initially developed.[9] Research has pointed out the Screening Tool for Risk on Nutritional Status and Growth (STRONGkids), which is the only method ever translated and culturally adapted into Portuguese,[3] as the best tool for nutrition screening in pediatric patients among the existing tools.[10–13] Few studies have evaluated the nutritional risk in pediatrics in Brazil and STRONGkids is the only tool recently validated in this country for this purpose.[14]

Studies that evaluated the performance of the STRONGkids nutrition screening tool indicate satisfactory validity, based on the cutoff points of the original instrument.[12–14] However, further studies are required to validate different cutoff points of this tool for clinical practice in Brazil.

2 | MATERIALS AND METHODS

2.1 | Study design and population

This cross-sectional study was carried out in a philanthropic hospital located in an urban area of Viçosa, Minas Gerais, a medium-sized Brazilian city.[15] The sample included children and adolescents admitted to the pediatric ward (clinical and surgical conditions) from July 2014 to July 2018. The inclusion criteria were age of ≥6 months and hospital stay of at least 1 day.[16] This study is part of the research project "STRONGkids as a nutrition screening method in pediatrics: Validity, reproducibility, and predictive capacity for health outcomes," which used the recommended sample calculation for validation studies. Considering a prevalence of malnutrition of 50%, sensitivity of STRONGkids of 71.9%, confidence level of 95%, and error tolerance of 5%, a sample of 621 patients was estimated for the study that validated the tool in Brazil.[14] In the present study, children with cerebral palsy, growth disorders, Down syndrome, and other chronic syndromes were excluded because the growth curves used in the anthropometric assessment did not apply to these groups.

2.2 | Data collection

Data related to sex, date of birth, diagnosis at admission, date of hospitalization, and date of hospital discharge were obtained from the medical record. Sociodemographic information about address and mother's education was collected via a semistructured questionnaire given to parents/guardians. The admission diagnosis was assessed according to the *International Classification of Diseases, 10th Revision*.[17]

2.3 | Nutrition screening

Within 48 h of hospital admission, patients were assessed using the version of the STRONGkids tool translated and culturally adapted to Portuguese.[3] The following clinical signs were investigated: occurrence of high-risk disease or major surgery planned; loss of muscle and fat mass; decreased food intake; diarrhea, nausea, vomiting, and pain; preexisting, dietetically advised nutrition intervention; and weight loss or absence of weight gain. Scores range from 0 to 5. According to the score, patients were classified into the categories of low risk (LR; 0 points), moderate risk (MR; 1–3 points), or high nutrition risk (HR; 4–5 points), as suggested by the tool's original study.[3]

2.4 | Anthropometry

The anthropometric assessment included the measurements of weight and length for height, according to the methodological guidelines of the Ministry of Health.[18] Children under 2 years were weighed on a pediatric digital electronic scale (ELP-25BB; Balmak), and the length was measured with a portable infantometer as they lay on their backs in bed. Participants older than 2 years and adolescents were weighed on a mechanical scale (Welmy), and height was measured with a vertical anthropometer (Alturexata). The indexes were calculated with the measurements and were converted into *z*-scores: weight for age (W/A), weight for length or height (W/H), length or height for age (H/A), and body mass index for age (BMI/A). Anthropometric data were analyzed using World Health Organization (WHO) Anthro[19] and WHO AnthroPlus.[20] The nutrition status was classified according to the growth curves recommended by WHO in 2006 for children younger than 5 years[21] and 2007 for children older than 5 years and adolescents.[22] The diagnostic criterion for acute malnutrition used a W/H *z*-score <-2 (5 years or younger) or a BMI/A *z*-score <-2 (5 years or older). For chronic malnutrition, the cutoff point was H/A *z*-score <-2, regardless of age group.[18] The presence of at least one type of malnutrition (acute and/or chronic) was also assessed.[16,23]

2.5 | Statistical analyses

Statistical analyses were performed using SPSS software (version 23; IBM), with statistical significance level $\alpha = 0.05$. The sample was described by measures of absolute and relative frequency, central tendency, and dispersion.

Receiver operating characteristic (ROC) curves were constructed, and the areas under the ROC curve (AUCs) were calculated with their respective 95% confidence intervals (CIs) to assess the accuracy of the STRONGkids score and anthropometric index values to identify patients with longer hospital stays (stay >5 days, according to the sample median). The ROC curves were constructed for the overall sample and stratified by age: <5 years old; ≥5 years old and <10 years old; and ≥10 years old. The AUCs were compared by their 95% CIs. In the presence of an overlap between the 95% CIs, it was considered that there was no significant difference between the AUCs. In addition, the discriminatory ability of STRONGkids to identify children and adolescents with acute and/or chronic malnutrition was assessed.

The means of length of hospital stay according to the STRONGkids score were compared according to the three nutrition risk categories (LR, MR, and HR) by analysis of variance, with data heteroscedasticity corrected by the Brown-Forsythe *F* statistic and post hoc Games-Howell test.

2.6 | Ethical aspects

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki and was approved by the Human Research Ethics Committee (CAAE: 20488013.9.0000.5153). Parents and guardians who agreed to participate in the research signed an informed consent form.

3 | RESULTS

A total of 599 patients were evaluated. The median age was 2.6 years (Interquartile range, 0.8–14.3), and the majority were residents in an urban area (74.8%) (Table 1).

The most frequent admission diagnoses were diseases of the respiratory system (36.4%); infectious and parasitic diseases (20.2%); injuries, poisoning, or external causes (8.0%); diseases of the digestive system (6.7%); and genitourinary (5.8%).

The median hospital stay was 5 days (mean, 5.7 days), ranging from 1 to 48 days. Regarding nutrition risk, 83.6% of the patients were classified as MR or HR.

Only the STRONGkids scoring system showed discriminatory ability to identify patients with longer hospital stays (AUC, 0.65; 95% CI, 0.59–0.71) compared with the W/A (AUC, 0.42; 95% CI, 0.36–0.48), W/H (AUC, 0.47; 95% CI,

TABLE 1 Sociodemographic characteristics, anthropometric assessment, and nutrition risk in hospitalized children and adolescents. Brazil (2014–2018)

Variables	*N*	%
Sex (*n* = 599)		
Male	331	55.30
Female	268	44.70
Age range (*n* = 599)		
<5 years	427	71.30
≥5 years and <10 years	130	21.70
≥10 years	42	7.00
Residence (*n* = 591)		
Urban	442	74.80
Rural	149	25.20
Mother's education (*n* = 579)		
≤8 years	281	48.53
9–11 years	259	44.73
≥12 years	39	6.74
Anthropometric assessment		
Acute malnutrition (*n* = 503)		
Yes	46	9.10
Not	457	90.90
Chronic malnutrition (*n* = 513)		
Yes	47	9.20
Not	466	90.80
Acute and/or chronic malnutrition (*n* = 513)		
Yes	84	16.40
Not	429	83.60
Nutrition screening—STRONGkids (*n* = 599)		
Low risk (0 points)	98	16.40
Medium risk (1–3 points)	399	66.60
High risk (4–5 points)	102	17.00

Abbreviation: STRONGkids, Screening Tool for Risk on Nutritional Status and Growth.

0.41–0.53), H/A (AUC, 0.44; 95% CI, 0.37–0.50), and BMI/A indexes (AUC, 0.44; 95% CI, 0.38–0.51) (Figure 1).

The comparative analysis of the means of hospital stay according to the STRONGkids score showed that patients scoring 3 (MR) behaved in a similar way to those scoring 4–5 (HR) in both groups analyzed: <5 years old and ≥5 years old (Figure 2).

STRONGkids also satisfactorily discriminated patients with acute (Figure 3A), chronic (Figure 3B), and any malnutrition (Figure 3C). The prediction of acute malnutrition had the largest AUC (0.82; 95% CI, 0.76–0.88), although there was no significant difference between types of malnutrition, because all 95% CIs overlapped.

4 | DISCUSSION

The results of the present study showed that in comparison with anthropometric indexes, only the STRONGkids score had the diagnostic accuracy to identify patients with the longest hospital stays. Furthermore, the AUC for STRONGkids did not overlap with the AUC for the anthropometric indexes, therefore showing significant differences. In addition, this is the first study in the scientific literature that carried out this comparison, corroborating the scientific evidence that demonstrates the clinical utility of STRONGkids. It is noteworthy that a longer hospital stay is associated with high susceptibility to infections, decline in functional capacity, malnutrition, and increased risk of death.[24]

The association between nutrition status and length of hospital stay has been frequently demonstrated in the literature.[25–27] The increased risk of malnutrition during hospitalization[28] can be explained by the frequent reduction in food consumption and by metabolic changes related to the underlying disease such as hypercatabolism and increased resting energy expenditure.[29]

A prospective, multicenter study identified a positive correlation between the risk of malnutrition and the length of hospital stay in Turkey.[4] The patients classified by STRONGkids as HR had a longer hospital stay. Studies carried out in several countries also confirmed the association between greater nutrition risk and length of hospital stay.[30–32] The comparative analysis between the length of hospital stay according to the STRONGkids score showed that patients who scored 3 behaved similarly to those who scored 4–5 (HR). Among children and adolescents who scored 3, 4, or 5, there was no significant difference in this parameter. This result suggests that, although they were classified as MR, patients with a score equal to 3 should be considered a higher priority, as well as those scoring 4 or 5 (HR). Among the possible factors that may explain the difference found in the cutoff points and guide future research, we highlight the definition of the original cutoff points proposed by Hulst et al[16] based on the similarity of the W/H index between the proposed risk groups (instead of the length of stay variable); differences in the characteristics of study populations; and differences in the types of validation used (concurrent or prospective). A prospective study conducted in Canada[33] to evaluate the performance of STRONGkids in pediatric patients described the tool as inappropriate for clinical use based on the original cutoff points when considering the agreement with the Subjective Global Nutritional Assessment (SGNA). The authors, by identifying alternative cutoff points for the classification of nutrition risk (0–1 score: no risk; 2–3 score: moderate risk; and 4–5 score: severe risk) by the ROC curve analysis, observed an improvement

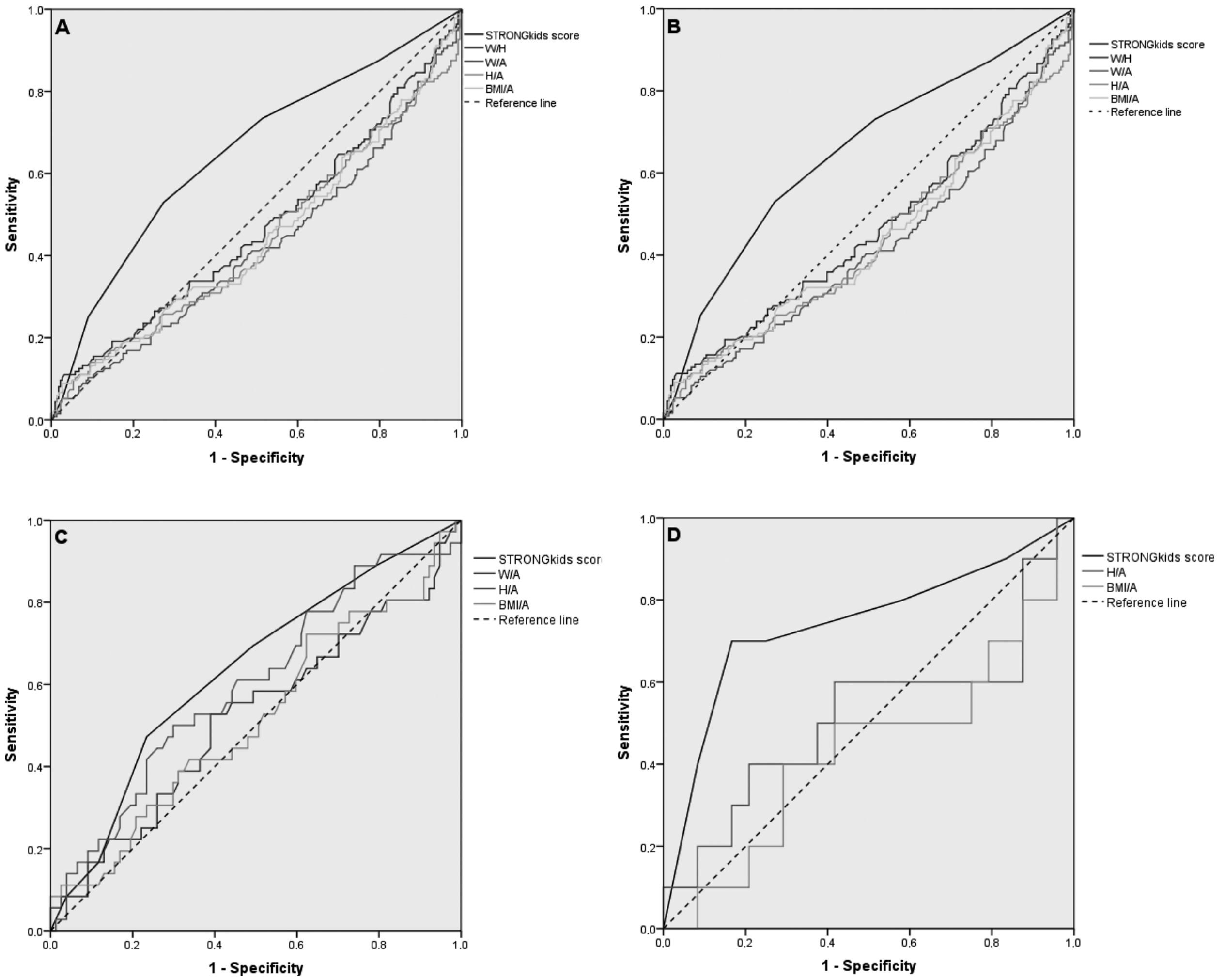

FIGURE 1 Receiver operating characteristic curves for the ability of the STRONGkids score and anthropometric indexes to discriminate patients with the longest hospital stays. Brazil (2014–2018). (A) Overall sample. (B) Patients <5 years old. (C) Patients ≥5 years old and <10 years old. (D) Patients ≥10 years old. BMI/A, body mass index for age; H/A, height for age; STRONGkids, Screening Tool for Risk on Nutritional Status and Growth; W/A, weight for age; W/H, weight for height

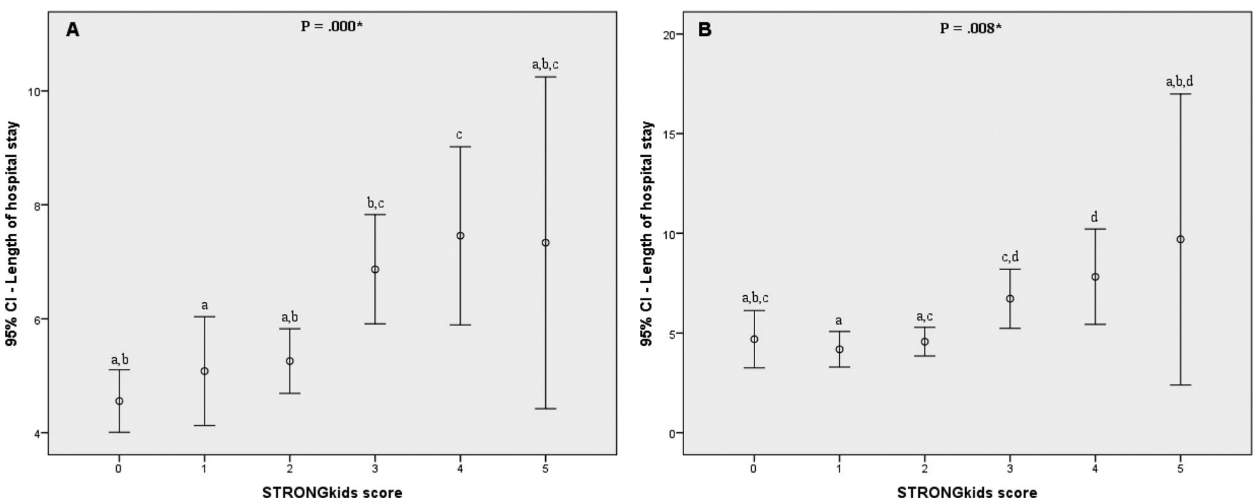

FIGURE 2 Means (95% CIs) of length of hospital stay according to the STRONGkids score. Brazil (2014–2018). (A) Patients <5 years old. (B) Patients ≥5 years old. Games-Howell test: different letters indicate significant differences between groups. *Analysis of variance (Brown-Forsythe *F* statistic). CI, confidence interval; STRONGkids, Screening Tool for Risk on Nutritional Status and Growth

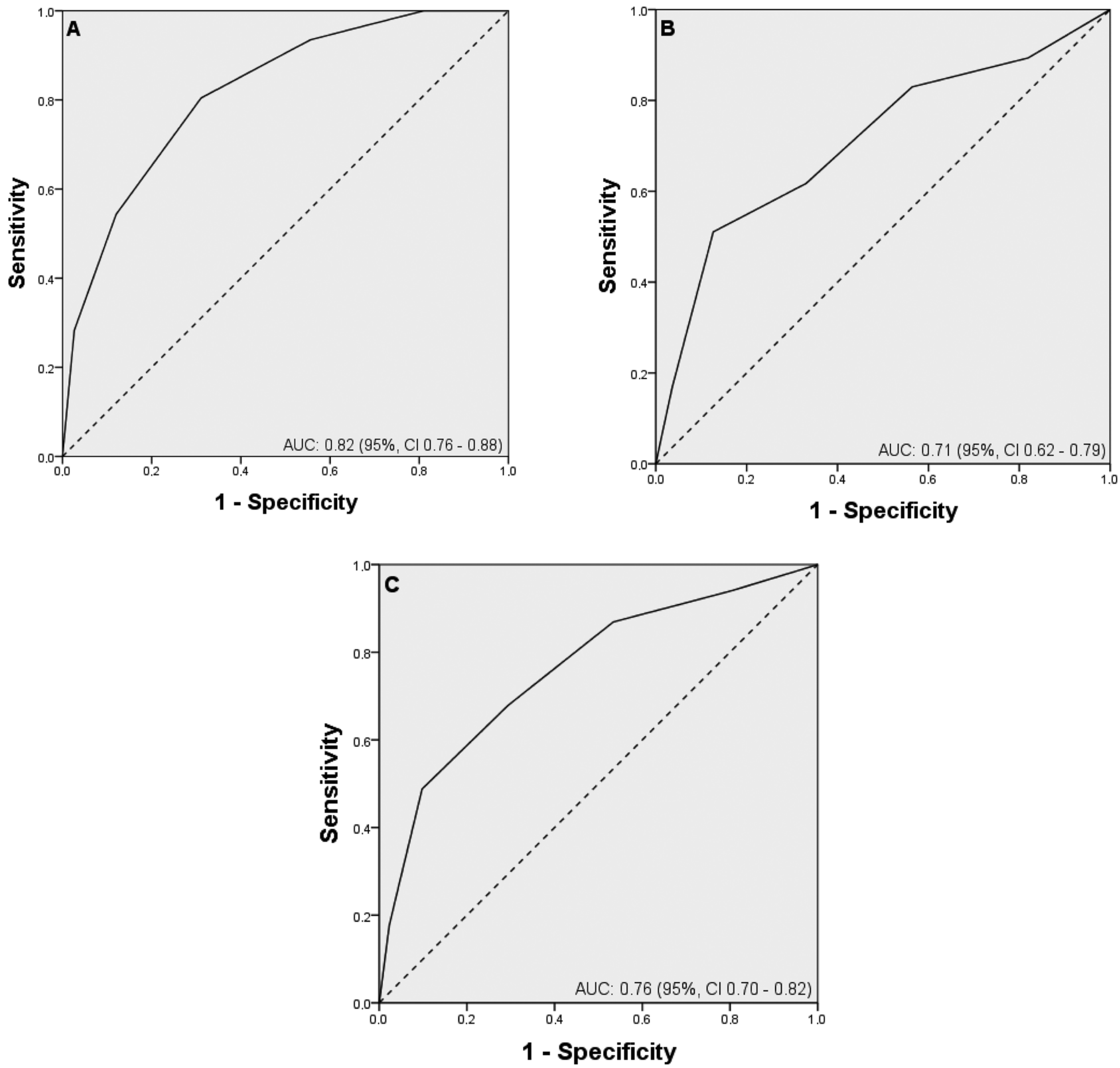

FIGURE 3 Receiver operating characteristic curves for the ability of the STRONGkids score to predict acute malnutrition (A), chronic malnutrition (B), and acute and/or chronic malnutrition (C). Brazil (2014–2018). AUC, area under the receiver operating characteristic curve; CI, confidence interval; STRONGkids, Screening Tool for Risk on Nutritional Status and Growth; solid line, AUC; dashed line, reference line

in the overall agreement of the tool with the SGNA without significantly affecting the prospective validity or the reliability between the evaluators. In addition, they observed a reduction in the percentage of sensitivity and an increase in specificity. However, the absence of a gold-standard reference constitutes a limitation for validating screening tools.[8] Furthermore, the study found no difference between the proposed score and the original score when predictive validation was performed.

This study also found that STRONGkids has the ability to satisfactorily discriminate patients with acute, chronic, and any malnutrition. Notably, although it is without significant difference, the largest AUC was for the prediction of acute malnutrition, which is an index of great interest because it reflects a recent nutrition deficit. Because the main objective of screening is to identify individuals at nutrition risk who will benefit from early intervention measures, the relationship between the method and recent weight loss is desirable.[30] The high sensitivity of STRONGkids meets a desired characteristic in tracking methods, which is to ensure there are no unidentified cases. Although this may imply a greater number of false positives, the nutrition deficit will be confirmed at the post-screening stage by nutrition assessment.[34] It is important to emphasize that risk screening should not deter from taking accurate anthropometric measures for growth assessment and definition of nutrition diagnosis.

The key strengths of this study are its large number of participants and its contribution to a growing body of literature on the implementation of STRONGkids in the South American population, as the tool was initially proposed for European populations. Studies to investigate the adequacy of cutoff values for the South American population are important for possible adjustments, improvement, and application of the method to other contexts. Finally, at least two important limitations need to be considered. First, this study was conducted in the setting of only one hospital, which limits the extrapolation of these results at the national level. Second, anthropometric measurements were not recorded in all patients.

5 | CONCLUSION

The strong performance of STRONGkids for the prediction of unfavorable hospitalization outcomes such as longer hospital stays, evidenced by this study, corroborates international literature. From these results, especially in South American hospitals where a complete assessment of all patients at moderate nutrition risk is not feasible, it is suggested that patients who scored 3 must be prioritized in a similar manner as those categorized as HR (4 or 5 points), if the purpose is to identify patients with the potential for longer hospital stays. Because this study was conducted in only one hospital, the extrapolation of results must be done carefully.

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CONFLICT OF INTEREST

None declared.

FINANCIAL DISCLOSURE

None declared.

AUTHOR CONTRIBUTIONS

Joice da Silva Castro and Andréia Queiroz Ribeiro contributed to the conception and design of the research; Carolina Araújo dos Santos and Carla de Oliveira Barbosa Rosa contributed to the design of the research; Joice da Silva Castro and Heloísa Helena Firmino contributed to the acquisition of the data; Andréia Queiroz Ribeiro and Carolina Araújo dos Santos contributed to the analysis and interpretation of the data; Joice da Silva Castro, Carolina Araújo dos Santos, and Andréia Queiroz Ribeiro drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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