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Nutrition Risk Assessed by STRONGkids Predicts Longer Hospital Stay in a Pediatric Cohort: A Survival Analysis

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Abstract

Background: We evaluated the impact of Screening Tool for Risk on Nutritional Status and Growth (STRONGkids) classification in time to discharge and verify whether the nutrition risk assessed by this method is an independent predictor of hospital length of stay (LOS) in pediatric inpatients. *Methods:* A cohort study was conducted in a Brazilian hospital from February 2014 to July 2018. The outcome in the survivor analysis was hospital discharge. Kaplan-Meier curves were used to estimate the cumulative survival time according to STRONGkids categories. Multivariable Cox proportional hazard models were fitted, and the adjusted hazard ratio (aHR), with respective 95% CI, was used to measure the strength of association. The discriminatory ability of STRONGkids was verified by a receiver operating characteristic curve *Results:* A total 641 patients were included in the study: 54.9% males, median age of 2.8 years. The frequencies of low, moderate, and high nutrition risk were 15.6%, 63.7%, and 20.7%, respectively. The mean LOS was 5.9 days. Survival curves differed significantly according to nutrition-risk categories. Patients classified as high risk had a 52% less chance of hospital discharge when compared with low-risk patients (aHR: 0.48; 95% CI, 0.35–0.65). STRONGkids score $\geq$ 3 showed the best discriminatory power to identify LOS. From this score, there was a significant increase in the days of hospitalization. *Conclusion:* The nutrition risk assessed by STRONGkids independently predicts LOS in pediatric patients. For this outcome, patients with 3 points (moderate risk) should be treated with the same priority as those with high risk. (*Nutr Clin Pract.* 2020;0:1–8)

Keywords

hospital stay; nutrition assessment; nutrition status; pediatrics; risk

Introduction

Malnutrition is a pathological condition associated with many adverse outcomes, including depression of immune system, increased risk of infection, wound-healing disorders, muscle loss, postoperative complications, and increased morbidity and mortality.[1–4] It is a debilitating and highly prevalent condition in the hospital setting.[5] In Brazil, rates may be $>50\%$.[6,7]

Clinical guidelines state that all patients should be screened for risk of malnutrition on admission and periodically during their hospital stay.[8,9] This is a simple procedure to rapidly identify patients at risk of malnutrition and provides a basis for prompt dietetic referrals.[10,11] In pediatrics, however, this practice has been hampered by the lack of consensus regarding the best screening method.[12,13]

The Screening Tool for Risk on Nutritional Status and Growth (STRONGkids) was developed and tested by Hulst et al (2010) in a prospective observational, multicenter study in the Netherlands. It consists of 4 aspects: subjective clinical assessment, high-risk disease or expected major surgery, nutrition intake, and weight loss or poor weight gain. According to the final score, the patient is classified as low nutrition risk, moderate nutrition risk, or high nutrition risk.[14] This is the only tool translated and cross culturally adapted for general Brazilian hospitalized children and adolescents,[15] but few studies have evaluated its performance and clinical usefulness in this population.[16,17]

The hospital length of stay (LOS) is recognized as a measure of clinical and economic relevance.[18] Its evaluation has traditionally been used as an indicator of

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healthcare efficiency and resource use because it is directly related to hospital costs.[19–21] Previous studies have demonstrated an association of LOS with greater susceptibility to infections,[18,22,23] medication side effects,[18] functional-capacity decline,[24,25] increased risk of falls,[26] and morbidity and mortality.[27,28] The relationship between malnutrition and hospital LOS has also been confirmed.[29–32] However, for pediatric nutrition risk, this relationship needs to be further explored, especially with longitudinal analyses and by statistical techniques, with adjustment for confounding variables. To the best of our knowledge, this methodology has not been used in studies with STRONGkids,[17] which could corroborate its validity and clinical usefulness in clinical practice.

The aim of this study was to evaluate the impact of STRONGkids risk categories in time to discharge, as well as to verify whether the nutrition risk assessed by this method is an independent predictor of hospital LOS in children and adolescents.

Methods

Study Design and Population

This prospective cohort study included patients admitted to the pediatric ward of a Brazilian hospital from February 2014 to July 2018. The inclusion criteria were age >1 month, hospital LOS >1 day, and nutrition screening within 48 hours.[14]

Data Collection

Sociodemographic data were collected using a structured questionnaire given to parents/caregivers before the nutrition screening. This questionnaire is part of the hospital admission protocol. Diagnosis, date of hospital admission, date of discharge, and clinical outcomes (discharge, transfer to a higher-complexity hospital, or death) were collected from medical records. The reasons for admission were classified according to the chapters of the *International Statistical Classification of Diseases and Related Health Problems 10th Revision* (*ICD-10*).[33]

The STRONGkids Brazilian version[15] was applied once in the first 24 hours of admission (or in the first 48 hours for weekend admissions) by 1 of the 4 trained dietitians. According to the final score, the patients were classified as low risk = 0 points, moderate risk = 1–3 points, or high risk = 4–5 points.

Variables

Outcome variables: The time to discharge was the event of interest in the survival analysis, and the time of admission until its occurrence was evaluated in days. Deaths and transfers to higher-complexity hospitals were censored.

Adjustment variables: The choice of variables for adjustment in the regression analysis considered factors that could affect the nutrition status according to previous studies, including sociodemographic,[34,35] maternal,[35,36] and clinical[37–39] variables, as described below:

- Sociodemographic variables and birth weight: age (years), sex (male or female), low birth weight ("yes" if <2500 g or "no" if ≥2500 g), residence (rural or urban), household size (number of members), household monthly income (<\$304.20, which is equivalent to 1 month's Brazilian minimum wage (MW); \$304.20 to <\$912.60, which is equivalent to 1 to <3 months' MW; \$912.60 to <\$1521.00, which is equivalent to 3 to <5 months' MW; and ≥\$1521.00, which is equivalent to ≥5 months' MW)
- Maternal variables: age (years) and years of education (≤8 years, 9–11 years, and ≥12 years)
- Clinical variables: diagnosis at admission, categorized into the 6 most prevalent conditions according to *ICD-10* chapters ("diseases of the respiratory system"; "infectious and parasitic diseases"; "diseases of the digestive system"; "diseases of the genitourinary system"; "injury, poisoning, and certain other consequences of external causes"; and "other causes").

Statistics

Continuous variables were tested for normality by using the Shapiro-Wilk test. Categorical variables are expressed as the number and proportion and compared by using the χ^2 test or Fisher exact test, as appropriate. Continuous variables were presented as mean and 95% CI and compared by using 1-way analysis of variance, with Brown-Forsythe correction for heteroscedastic data, and Games-Howell post hoc test.

Kaplan-Meier curves were performed for the total sample and according to STRONGkids classification into 2 (low risk vs moderate risk/high risk) and 3 (low risk vs moderate risk vs high risk) categories. The log-rank and Peto tests were used for the comparisons of the survival curves. Multivariate Cox proportional hazard regression analysis was performed to identify the predictor variables of discharge. Proportional hazards assumptions were checked with the Schoenfeld residual test. Crude hazard ratio (cHR) and adjusted hazard ratio (aHR), with 95% CI, were used to measure the strength of association. HRs were adjusted for sociodemographic, maternal, and clinical variables. As complementary investigation to verify the relationship between STRONGkids and discharge, the predictive performance of the STRONGkids scores in identifying patients with longer hospital LOS (categorized according to the sample median) was evaluated using receiver operating characteristic (ROC) curve. The days of hospitalization were also compared according to the final score of the STRONGkids.

Data analysis was performed by using Stata software version 13.0 (StataCorp, College Station, TX). Significance level was set at $\alpha = .05$.

Ethical Aspects

This study was conducted in accordance with the ethical standards of the Helsinki Declaration and was approved by the human research ethics committee (n. 841.492/2014; CAAE: 20488,013.9.0000.5153). The parents/caregivers who agreed to participate in the study signed an informed consent form.

Results

A total of 763 pediatric patients were admitted to the hospital in the period when the data were collected. After exclusions (due to hospital LOS < 48 hours and age <1 month), 641 patients were consecutively included. The mean age was 3.9 years (95% CI, 3.6–4.2), 54.9% were boys, and 61.2% were from an urban area. Median maternal age was 29 years (95% CI, 28.5–29.6), and about half (50.2%) of the mothers had ≤8 years of schooling. Mean hospital LOS was 5.9 days (95% CI, 5.6–6.4), ranging from 1 to 48 days. Respiratory disease was the most prevalent cause of hospital admission (35.7%). Overall, 15.6% of the children were classified as low risk, 63.7% as moderate risk, and 20.7% as high risk. Baseline characteristics according to STRONGkids classification are shown in Table 1. The frequency of high nutrition risk was higher among low-birth-weight patients when compared with those without low birth weight, and children with high nutrition risk had a longer hospital LOS. The nutrition risk was lower in children of mothers with 9–11 years of schooling.

More than 75% of the hospital discharges occurred within 10 days of hospitalization (Figure 1A).The mean time to hospital discharge was 6.4 days (95% CI, 5.9–6.9) in patients classified as moderate risk/high risk, as compared with 4.8 days (95% CI, 4.2–5.4) in the low-risk group, with significant differences between the 2 survival curves (Figure 1B). The differences between the survival curves were also statistically significant when comparing the 3 risk categories separately (Figure 1C).

During the study period, 18 (2.8% of the total sample) patients were transferred to higher-complexity hospitals: 6 (33.3%) in the moderate-risk group and 12 (66.7%) in the high-risk group. There were 3 deaths: 1 (33.3%) in the moderate-risk group and 2 (66.7%) in the high-risk group (data not shown).

After adjusting for sociodemographic data, maternal variables, and diagnosis at admission, STRONGkids significantly predicted hospital LOS. Patients classified as moderate risk/high risk had a 28% less chance of hospital discharge (aHR: 0.72; 95% CI, 0.56–0.91) when compared with those classified as low risk. When assessing the 3 risk categories separately, patients classified as high risk had a 52% less chance of hospital discharge when compared with

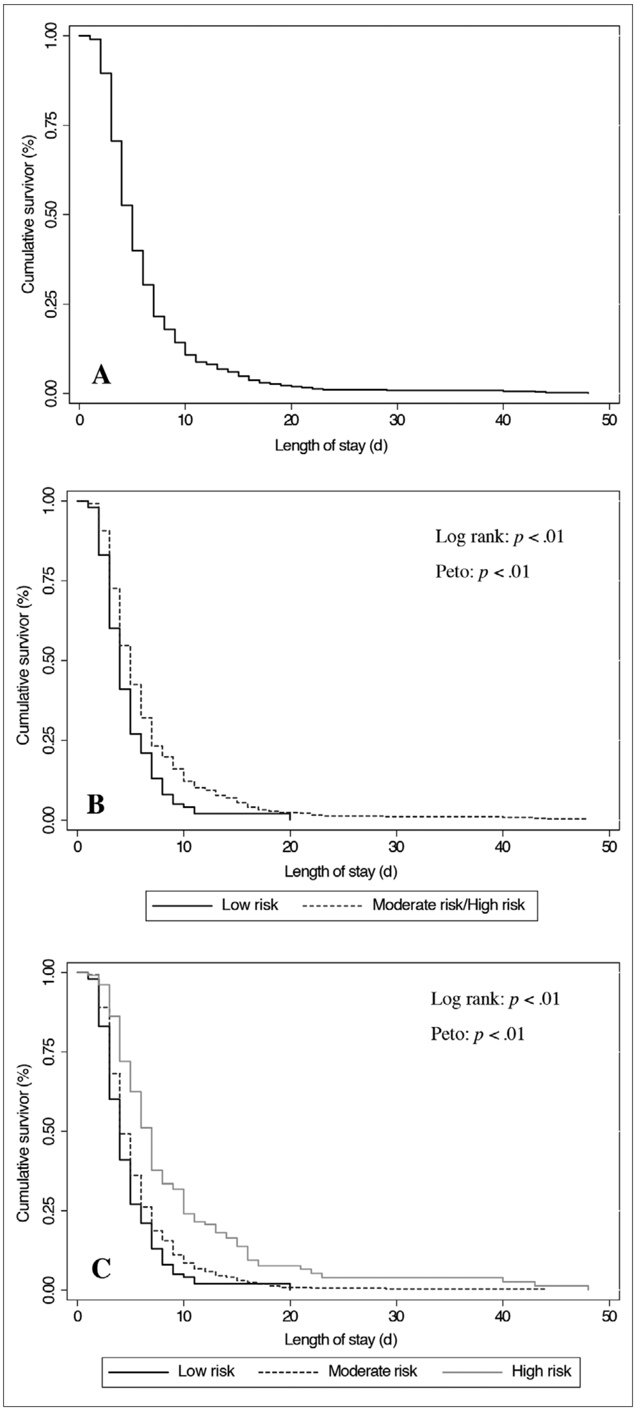

Figure 1. Kaplan-Meier curves of (A) the total sample, (B) the low-risk vs moderate-risk/high-risk groups, and (C) the low-risk vs moderate-risk vs high-risk groups.

Table 1. Patient Characteristics According to STRONGkids Classification.

Variable	Low risk (n = 100; 15.6%)	Moderate risk (n = 408; 63.7%)	High risk (n = 133; 20.7%)	*P*-value
Patient characteristics				
Age, y (n = 641)	3.8 (3.0–4.5)	3.7 (3.4–4.1)	4.5 (3.8–5.3)	NS[d]
Sex (n = 641)				
Female	45.0 (15.6)	185.0 (64.0)	59.0 (20.4)	NS[e]
Male	55.0 (15.6)	223.0 (63.4)	74.0 (21.0)	
Low birth weight (n = 574)				
No	83.0 (16.8)	331.0 (67.0)	80.0 (16.2)	<.001[e]
Yes	7.0 (8.8)	38.0 (47.5)	35.0 (43.8)	
Diagnostic groups[a] (n = 638)				NS[f]
Diseases of the respiratory system	30.0 (13.2)	145.0 (63.6)	53.0 (23.2)	
Infectious and parasitic diseases	19.0 (15.1)	89.0 (70.6)	18.0 (14.3)	
Diseases of the digestive system	5.0 (11.9)	25.0 (59.5)	12.0 (28.6)	
Diseases of the genitourinary system	10.0 (27.8)	19.0 (52.8)	7.0 (19.4)	
Injury, poisoning, and certain other consequences of external causes	4.0 (7.7)	38.0 (73.1)	10.0 (19.2)	
Other	30.0 (19.5)	91.0 (59.1)	33.0 (21.4)	
Hospital LOS, d (n = 641)	4.8 (4.2–5.4)[g]	5.6 (5.1–6.0)[g]	8.2 (7.0–9.4)[h]	<.001[d]
Family characteristics				
Maternal age, y (n = 618)	28.9 (27.7–30.2)	28.9 (28.2–.6)	29.7 (28.4–31.1)	NS[d]
Maternal education[b] (n = 621)				
≤8 y	44.0 (14.1)	190.0 (60.9)	78.0 (25.0)	.005[e]
9–11 y	49.0 (18.6)	179.0 (67.8)	36.0 (13.6)	
≥12 y	4.0 (8.9)	29.0 (64.4)	12.0 (26.7)	
Family members (n°) (n = 619)	4.1 (3.9-4.3)	3.9 (3.8-4.1)	4.3 (4.1-4.6)	NS[d]
Residence (n = 632)				
Urban	71.0 (15.2)	309.0 (66.0)	88.0 (18.8)	NS[e]
Rural	27.0 (16.5)	96.0 (58.5)	41.0 (25.0)	
Family monthly income[c] (n = 618)				
<$304.20	19.0 (17.1)	65.0 (58.6)	27.0 (24.3)	NS[f]
$304.20 to <$912.60	77.0 (16.3)	302.0 (64.0)	93.0 (19.7)	
$912.60 to <$1521.00	3.0 (10.0)	22.0 (73.3)	5.0 (16.7)	
≥$1521.00	0.0 (0.0)	4.0 (80.0)	1.0 (20.0)	

Data are presented as number (%) or mean and 95% CI.
ANOVA, analysis of variance; NS, not significant.
[a] International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10)
[b] Years of formal education.
[c] 304.20 USD = R$ 724.00 = 1 months' Brazilian minimum wage (exchange rate in February 2014).
[d] ANOVA with Brown-Forsythe correction and Games-Howell post hoc.
[e] Pearson $\chi 2$ test.
[f] Fisher exact test.
[g,h] Different letters indicate significant differences between groups.

Table 2. Crude and Adjusted Cox Regression Analysis and Proportional Hazards Ratio for Discharge According to STRONGkids Classification.

STRONGkids classification	cHR (95% CI)	*P*-value	aHR[a] (95% CI)	*P*-value
2 categories				
Low risk	1	0.002	1	.006
Moderate risk/high risk	0.70 (0.57–0.87)		0.72 (0.56–0.91)	
3 categories				
Low risk	1	<0.001	1	
Moderate risk	0.81 (0.65–1.01)		0.79 (0.621–1.0)	.056
High risk	0.48 (0.36–0.61)		0.48 (0.35–0.65)	<.001

aHR, adjusted hazard ratio; cHR, crude hazard ratio.
[a]Adjusted for age, sex, low birth weight, residence, household size, household income, maternal age, maternal schooling, and diagnosis at admission.

those classified as low risk (aHR: 0.48; 95% CI, 0.35–0.65) (Table 2).

The area under the ROC curve was 0.65 (95% CI, 0.61–0.69), indicating that the STRONGkids score has discriminatory power to identify patients with longer than median hospital LOS (≥ 5 days). The score with the best discriminatory ability was ≥3 (64.6% of correct classifications), with sensitivity of 56.2% and specificity of 69.9% for this outcome (Figure 2).

When comparing the hospital LOS according to the STRONGkids final score, it was found that for ≥3 points, there was a significant increase in the days of hospitalization. Children with 3 (moderate risk), 4 (high risk), and 5 points (high risk) were statistically similar in this parameter (Figure 3).

Discussion

This study demonstrates that the STRONGkids risk classification is an independent predictor of longer hospital stay. The Kaplan-Meier curves allowed visualization for how the categories of risk affect the LOS. It was also demonstrated that the scoring system has discriminatory ability to identify patients with longer hospitalization and that a score ≥3 points was related to a significant increase in this outcome.

The frequency of nutrition risk (moderate or high) was high (84.4%), as also demonstrated by other studies conducted in Brazil, with prevalence rates ranging from 69%[40] to 75.4%.[41] This worrying scenario reinforces the importance of implementing nutrition-screening protocols in pediatric wards. In clinical practice, the nutrition care of hospitalized children and adolescents is still not standardized and is based mainly in anthropometric measures, which detect malnutrition already installed.[12]

Because of the methodological difficulty to validate a nutrition-screening tool, mainly because of the lack of a gold standard for comparison,[42,43] the evaluation of the performance of the methods in predicting relevant events, such as the LOS, is a well-established procedure.[12,34,44,45] The ability to predict clinical outcomes (predictive validity) is a highly desirable characteristic for nutrition-screening methods,[9] and this aspect is considered to be superior to the agreement of this method with anthropometric measures (concurrent validity).[12]

The relationship between nutrition status and hospital LOS is not necessarily causal.[34,46] Hospital stay is a multifactorial outcome, being the result of a complex interaction between patient characteristics, environmental factors, medical practices, and hospital characteristics.[47] Despite this, the evidence of this association is a consistent finding in the literature, even in studies with pediatrics.[3,13,48] It should be considered that the inverse impact (of LOS on nutrition status) is also a reality because, during this period, there is a frequent reduction in food consumption and metabolic changes related to the underlying disease (such as hypercatabolism, negative energy balance, and increased resting energy expenditure).[49,50] The frequency of malnutrition after 10 days of hospitalization can reach 70%,[51] and the weight loss can affect >50% of children aged <5 years during the hospitalization.[52]

Children exposed to nutrition risk at the beginning of hospitalization were discharged later than those not exposed. After adjusting for confounding variables, this association remained significant, indicating the independent effect of nutrition risk. The similarity between the cHRs and aHRs shows how strong this relationship is. Studies that compared the mean hospital LOS according to STRONGkids risk categories also identified this association, especially for those classified as high risk.[53–55]

It has been demonstrated that hospital LOS can be increased from 2.3 to 9 days in at-risk and/or malnourished patients[30,56,57] and that the time of hospitalization be increased from 30% to 100% in the presence of malnutrition.[58] In our study, children classified as high risk had a mean LOS 46.4% longer than those classified as moderate risk and 70.8% longer than those in the low-risk group. The LOS for high-risk patients was, on average, 3.4 days longer than for those classified as low risk.

In addition to its relevance to the patient's health and recovery, nutrition status is an important determinant of healthcare expenses. In a study conducted in Brazil in 25 hospitals, the costs in malnourished patients had an average increase of 60.5% (reaching ≤308.9%) compared with well-nourished patients.[32] Other studies that assessed the economic impact of malnutrition identified increases of 20%,[59] 30%,[60] and ≤60%.[61] In an economic report published by the British Association for Enteral and Parenteral Nutrition, the annual cost per individual with malnutrition, or at risk of malnutrition, is 3–4 times higher than that for a well-nourished patient.[62] The association between the nutrition risk assessed by STRONGkids with higher hospital costs has been demonstrated in China[5,54] and Korea.[63]

Investments in nutrition care are highly cost-effective,[64] with positive impacts for both the patient and the health system.[65] In this context, STRONGkids stands out for being a simple, quick, and low-cost method. Because it does not require anthropometric measures or equipment expenses, and because of it its speed of application (on average, 3 minutes),[66] resources can be concentrated on higher-priority actions. The reliability of STRONGkids has been demonstrated even when applied by different professionals[63,67] and by nonspecialized staff,[38] which also contributes to its feasibility in clinical practice.

In the STRONGkids' original article,[14] the *z*-scores of weight for height were used to define the score for each risk category (low risk, moderate risk, and high risk). Children who scored 1–3 points were included in the same group (moderate risk) because of their similarities in this parameter. Our results demonstrate that if it is of interest to identify patients with a probable longer hospital LOS (predictive ability), instead of anthropometric alterations, a score of 3 would be sensitive to indicate this outcome. This cutoff point also had the best discriminatory ability, according to the ROC curve analysis.

This study has some limitations. It was a single-center study, so the results may not be extrapolated to other populations. In addition, the variation of dietitians applying STRONGkids should be mentioned, although previous studies[38,63,66–68] have confirmed the method's interrater reproducibility.

The main strength of this prospective study is that it provides new information on the independent effect of the pediatric nutrition risk in hospital LOS. To our best knowledge, this is the first study to use survival analysis as a STRONGkids' performance indicator. Besides, this is the largest cohort study conducted in Brazil to evaluate the pediatric nutrition risk.

In conclusion, the nutrition risk assessed by STRONGkids is an independent predictor for the time to discharge in hospitalized pediatric patients. For this outcome, patients with a score of 3 points (moderate risk) should be prioritized in the same manner as those who score 4 or 5 points (high risk). The results confirm the high prevalence of this condition in Brazil and reinforce the importance of implementing nutrition-screening routines in pediatric settings.

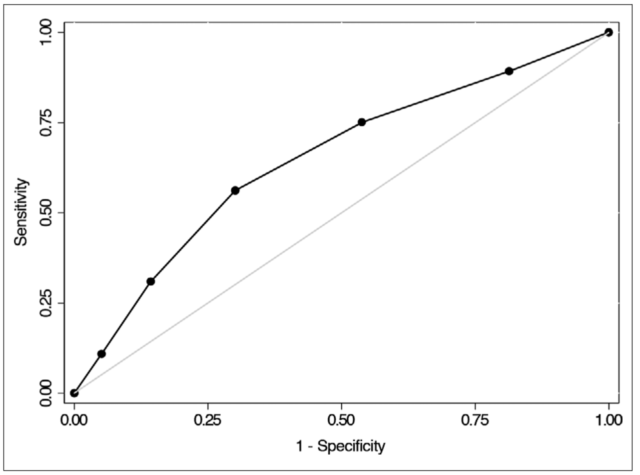

Figure 2. Receiver operating characteristic (ROC) curve of the STRONGkids score to identify a longer than median hospital stay (AUC, 0.65; 95% CI, 0.61–0.69). AUC, area under the ROC curve.

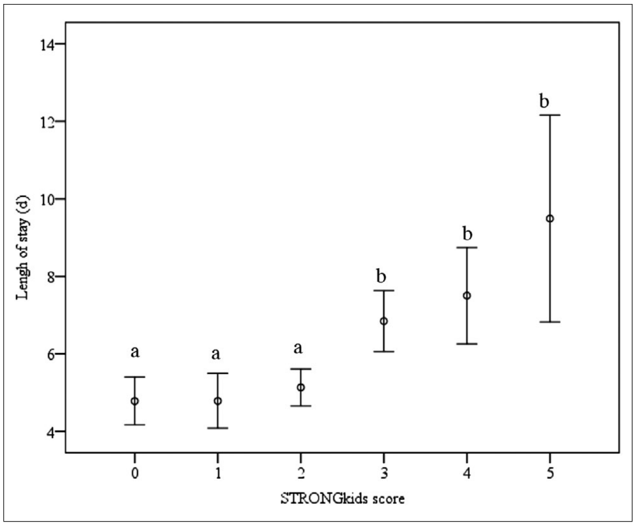

Figure 3. Mean and 95% CI of hospitalization length of stay according to the STRONGkids score.[a,b]Different letters indicate significant differences in analysis of variance with Brown-Forsythe correction and Games-Howell post hoc test.

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Statement of Authorship

C. A. Santos, C. O. B. Rosa, S. C. C. Franceschini, H. H. Firmino, and A. Q. Ribeiro contributed to the conception and design of the research; C. O. B. Rosa and S. C. C. Franceschini contributed to the design of the research; C. A. Santos and H. H. Firmino contributed to the acquisition and analysis of the data; C. O. B. Rosa and S. C. C. Franceschini contributed to the interpretation of the data; C. A. Santos and A. Q. 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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