Original Article

The performance of STRONGkids
in the early detection of hospital malnutrition

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Abstract

Background Hospital malnutrition in children can increase morbidity and mortality, regardless of the type of illness. *The Screening Tool for Risk on Nutritional Status and Growth* (STRONGkids) is a practical and easy nutritional risk screening tool that has been widely validated in several countries.

Objective To examine the performance of STRONGkids for the early detection of hospital malnutrition in pediatric inpatients.

Methods This cross-sectional study was conducted in the pediatric ward of Dr. Zainoel Abidin General Hospital, Banda Aceh, Indonesia. The pediatric inpatients' STRONGkids scores were calculated within 24 hours of admission. We used the chi-square test to compare the proportion of at-risk children based on STRONGkids scores with the prevalence of hospital malnutrition based on serial weight measurement. We also determined the sensitivity, specificity, as well as positive and negative predictive values of STRONGkids for detecting hospital malnutrition, with percentage of weight loss between admission and discharge as the gold standard.

Results Out of 75 subjects, 48% were male. The hospital malnutrition prevalence was 29.3%. STRONGkids score was significantly associated with hospital malnutrition (P=0.023). The sensitivity, specificity, positive predictive value, and negative predictive value of STRONGkids for detecting hospital malnutrition was 77.3%, 54.7%, 41.4%, and 85.2%, respectively.

Conclusion With its good sensitivity, the STRONGkids tool is effective in identifying those at risk of hospital malnutrition. In addition, with its high NPV, a "no-risk" score also effectively implies that the child is likely not to have hospital malnutrition. **[Paediatr Indones. 2022;62:192-7 DOI: 10.14238/pi62.3.2022.192-7]**.

Keywords: hospital malnutrition; STRONGkids; nutritional risk; screening; children

Hospital malnutrition is a malnutrition experienced during hospitalization, either on admission, during treatment, or at the time of hospital discharge.[1-4] The incidence of hospital malnutrition incidence remains relatively high. A multicenter study of 2,567 patients aged 1 month to 18 years in 14 centers in 12 European countries found weight loss in 217/938 (23%) patients hospitalized for more than four days.[5] The prevalence of hospital malnutrition varies across settings from 23% to 51.6%.[1] In 2017, a study in Denpasar, Bali, reported a pediatric in-hospital malnutrition incidence of 17.5%.[6] A 2013 study in Makassar, South Sulawesi, reported a prevalence of 8.9%.[2]

Several screening tools are available to predict the risk of pediatric hospital malnutrition.[7] The *Screening Tool for Risk of Nutritional Status and Growth* (*STRONGkids*) has been validated for use in various countries with good reproducibility and predictive capacity. This tool can easily be incorporated in

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clinical practice for the identification of nutritional risk in children and adolescents.[8,9] Several studies have shown that this tool was associated with anthropometric measurements during pediatric inpatient admission.[10-12]

Early risk detection needs to be carried out immediately to prevent hospital malnutrition, nutrition-related complications, growth disorders, risk of infections, and prolonged hospitalization.[13] This study was conducted to examine the performance of STRONGkids for the early detection of pediatric hospital malnutrition.

Methods

This cross-sectional study was conducted at Dr. Zainoel Abidin Regional General Hospital (RSUDZA), Banda Aceh, Indonesia, from January to March 2021. Subjects were patients aged 1 month to 18 years who had been hospitalized in the RSUDZA pediatric ward for three days or more. Patients had to have been born at term to be included in the study. Patients with a terminal or end-stage condition, fluid retention disorder (edema), tumor or mass, hydrocephalus, congestive heart failure, nephrotic syndrome, or physical changes or congenital abnormalities that hinder anthropometric measurements, were excluded. We also excluded patients who were transferred to the intensive care unit or other wards, required ventilators, or who had been readmitted with the same condition within seven days after discharge. Subjects were recruited consecutively.

We calculated the STRONGkids score and measured the admission weight of all subjects within the first 24 hours of admission. The STRONGkids forms is presented in **Table 1**. We performed serial measurement of subjects' weight during the course of hospitalization as well as at discharge. Discharge weight was measured when the patient no longer required care and was allowed to leave the hospital. The percentage of weight loss was calculated using the following formula:

$$\% \text{ weight loss} = \frac{\text{Admission on weight} - \text{discharge weight}}{\text{Admission weight}} \times 100\%$$

Subjects' nutritional status was determined using weight-for-height based on the *World Health Organization* (*WHO*) growth charts for children 5-years-old and under, and based on the *Centers for Disease Control and Prevention* (*CDC*) growth charts for children over five years old.

To assess the primary outcome, i.e., the diagnostic value of the STRONGkids screening tool in predicting hospital malnutrition incidence with a significance level of 95% ($\alpha = 0.05$), a minimum of 75 subjects was required. Data were analyzed using *SPSS version 25.0* for *Mac* (*IBM*, Armonk, New York). Hospital malnutrition was defined as more than 2% weight loss in the first seven days of admission, 5% weight loss in days eight to 30 of admission, or 10% weight loss in after 30 days of admission. STRONGkids scores were classified as "at risk" when they fell into the moderate- or high risk categories and "no risk" when they fell into the low risk category. We performed the chi-square test to assess the association between STRONGkids score classification and hospital malnutrition. We also calculated the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), as well as the positive and negative likelihood ratios of STRONGkids, with hospital malnutrition status based on percentage of weight loss as gold standard.

Results

We obtained a total of 75 subjects, comprising 39 girls (52%) and 36 boys (48%). Most subjects were in the age groups of <2 years and >10 years, with 26/75 (34.7%) subjects in each group. Upon admission, 37 subjects (49.3%) had normal nutritional status, 19 (25.3%) were undernourished, 7 (9.3%) were severely malnourished, 3 (4%) were overweight, and 9 (12%) were obese. Thirty subjects (40%) had a single diagnosis and 45 (60%) had multiple diagnoses. The nature of their diagnoses, as well as other subject characteristics, are presented in **Table 2**.

Based on their STRONGkids scores, 41 subjects were predicted to be at risk of hospital malnutrition, of whom 17 (41.5%) experienced the condition. In addition, 29 subjects (85.3%) were correctly predicted not to be at risk of hospital malnutrition; however, five subjects (14.7%) who were predicted not to be at risk experienced the condition. The chi-square test revealed a significant association between STRONGkids score category and hospital malnutrition (P=0.023) (**Table 3**). The STRONGkids tool had a sensitivity of 77.3%,

Table 1. STRONGkids form[14]

No	STRONGkids parameters	Score	→	Points
1	Is there any underlying disease with risk of malnutrition or a planned major surgery?	No		Yes = 2
2	Is the patient in a poor nutritional status assessed by subjective clinical assessments (reduced subcutaneous fat and/or muscle mass and/or hollow face)?	No		Yes = 1
3	Is any of the following items present? • Excessive diarrhea (≥5 times per day) and/or vomiting (> 3 times per day) in the last few days? • Reduction of food intake in the last few days prior to admission (excluding fasting for elective or surgical procedures)? • Suggested nutritional intervention according to the previous diet? • Inability to consume sufficient food due to pain?	No		Yes = 1
4	Has there been any weight loss or no weight gain (infants < 1 year) over the past few weeks/ months?	No		Yes = 1

Score category
0 = low risk
1-3 = moderate risk
4-5 = high risk

Total score:
Category:

Diseases with risk of malnutrition (item 1)
• Psychiatric eating disorder
• Burns
• Bronchopulmonary dysplasia (up to 2 years old)
• Celiac disease (active)
• Cystic fibrosis
• Dysmaturity/prematurity (until corrected at 6 months old)
• Heart disease, chronic
• Infectious disease
• Inflammatory bowel disease
• Cancer
• Liver disease, chronic
• Kidney disease, chronic
• Pancreatitis
• Short bowel syndrome
• Muscle disease
• Metabolic disease
• Trauma
• Mental disability/retardation
• Planned major surgery
• Non-specific (determined by physician)

specificity of 54.7%, PPV of 41.4%, NPV of 85.2%, positive likelihood ratio of 1.70, and negative likelihood ratio of 0.41.

Discussion

To our knowledge, this study was the first to assess the performance of the STRONGkids screening tool in the early detection of hospital malnutrition. As a screening tool, STRONGkids is inexpensive, practical, and easy to use by medical personnel, such as nurses. In addition, STRONGkids has met the requirements of a malnutrition risk screening tool by the *European Society for Parenteral and Enteral Nutrition* (*ESPEN*),

which include (1) describing the current nutritional condition, (2) describing weight loss incidence, (3) describing a decrease in food intake, and (4) describing the severity of the disease.[15]

Children are more susceptible to malnutrition than adults because they require greater energy for growth and development and have limited energy reserves. The need for essential nutrients increases during various conditions, such as stress, illness, and therapy with antibiotics or catabolic and anabolic agents. Hospitalized patients usually experience a decrease in nutritional status due to reduced food intake caused by diseases that lead to decreased appetite, gastrointestinal disorders, reduced ability to chew or swallow, or mandatory fasting required for

Table 2. Subject characteristics

Variables	N=75
Gender	
Male	36 (48.0)
Female	39 (52.0)
Age	
< 2 years	26 (34.7)
2 to < 5 years	15 (20.0)
5 to 10 years	8 (10.7)
>10 years	26 (34.6)
Nutritional status	
Normal	37 (49.3)
Undernutrition	19 (25.3)
Malnutrition	7 (9.4)
Overnutrition	3 (4.0)
Obesity	9 (12.0)
Admitting diagnosis	
Single	30 (40.0)
Multiple	45 (60.0)
Nature of diagnosis	
Gastroenterohepatologic	24 (32.0)
Neuropediatric	18 (24.0)
Pulmonology	11 (14.7)
Infectious & tropical disease	4 (5.3)
Nutrition & metabolic disease	2 (2.7)
Cardiologic	2 (2,7)
Nephrologic	3 (4.0)
Hematology-oncologic	7 (9.3)
Allergy-immunologic	3 (4.0)
Endocrine	1 (1.3)
Duration of hospitalization	
3-7 days	64 (85.3)
>7 days	11 (14.7)
Hospital malnutrition	
Yes	22 (29.3)
No	53 (70.7)

Table 3. Association between STRONGkids score category and hospital malnutrition

STRONGKids	Hospital malnutrition		Total	P value
	Yes	No		
At risk, n (%)	17 (41.5)	24 (58.5)	41 (100.0)	0.023
No risk, n (%)	5 (14.7)	29 (85.3)	34 (100.0)	

in the criteria used to define hospital malnutrition, differences in ethnic background and other patient characteristics may also account for such disparate prevalence rates. Hartman et al. argued that differences in the incidence of hospital malnutrition across studies were due to the heterogeneity of investigators and data collected, inconsistent definitions used to classify nutritional status and diverse study populations, as well as the type of institution and country of recruitment.[22] Many factors, including those inherent to patients, such as age, nutritional status at disease onset, medical and obstetric history, as well as socioeconomic status, have been reported to lead to a high incidence of hospital malnutrition. Other factors are associated with hospitalization, such as procedures that required fasting, acceptance of diet, time required to complete meals, and effectiveness of the diet, as well as the patient's disease and disease severity.[1]

There was a significant association between STRONGkids and hospital malnutrition (P=0.023), showing that STRONGkids was effective at predicting the occurrence of pediatric hospital malnutrition. Previous studies have also recommended that the STRONGkids tool be used to identify children at risk of malnutrition.[23,24] A previous study compared several malnutrition risk screening tools and concluded that STRONGkids effectively predicted children at risk of malnutrition.[25] Similarly, Joosten et al. concluded that STRONGkids was the fastest, as well as the most reliable and practical to use, amongst several malnutrition risk screening tools.[26]

We found that STRONGkids had 77.2% sensitivity, 54.7% specificity, 41.4% PPV, and 85.2% NPV, similar to previous studies.[13,27] A multicenter study in Italy reported that STRONGkids had 71% sensitivity, 53% specificity, 21% PPV, and 85% NPV.[27] A study reported 71.9% sensitivity, 49.1% specificity, 11.9% PPV, and 94.8% NPV.[13] A 2020 study noted sensitivity, specificity, PPV, and NPV values of 84.8%, 26.7%, 49.8%, and 67.2%, respectively.[8] The variation in outcomes may have been due to differences in

specific diagnostic or therapeutic procedures.[16,17]

The prevalence of pediatric hospital malnutrition found in our study was 29.3%. Our finding is similar to that of a study on 116 children aged 1-15 years at Dr. Hasan Sadikin Hospital, Bandung, West Java, which reported a prevalence of 28.44%,[18] and another study at Sanglah Hospital, Denpasar, Bali, which reported a prevalence of 30.1%.[19] Both studies employed similar criteria for hospital malnutrition as the present study. Other studies that used different criteria for hospital malnutrition resulted in different prevalence rates. i.e., 15.5%[20] and 51.6%.[21] Kac *et al.*[20] defined hospital maltnutrition as more than 0.5 SD of weight loss and obtained a prevalence of 15.5%, while Rocha *et al.*[21] who considered any weight loss as hospital malnutrition obtained a prevalence of 51.6%. Besides differences

interpretation of each STRONGkids parameter. The STRONGkids assessment is subjective, thus, different assessors may interpret it differently. Previous studies have adjusted the STRONGkids score for several other variables, such as nutritional status on admission, admitting diagnosis, and duration of hospitalization.[6,13,14,23]

We noted a relatively high NPV of 85.2%, similar to a previous study which reported an NPV of 85%.[27] Higher NPV values were obtained by Huysentruyt *et al.*[13] (94.8%) and Wonoputri *et al.*[18] (100%). A high NPV indicates that the STRONGkids tool effectively identified patients who were unlikely to get hospital malnutrition.

Past studies demonstrated that STRONGkids is a sensitive, but not very specific screening tool. Therefore, it is highly effective in detecting children who are not at risk of hospital malnutrition. Besides its ease of use, another advantage of this tool is that it can readily be used by medical personnel other than physicians, such as nurses and nutritionists. This screening tool has also been validated in various hospitals around the world with consistent results.[8,9]

We conclude that with its high sensitivity, STRONGkids is an effective screening tool to identifying children at risk of hospital malnutrition when scores indicate moderate or high risk. With its high NPV, it is also able to identify those unlikely to develop hospital malnutrition, given a prevalence approximating our rate of 29.3%.

Conflict of interest

None declared.

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