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Assessment of the STRONGkids screening tool: A cross-sectional study in Turkish children

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ABSTRACT

Objective: We aimed to determine the risk of malnutrition in hospitalized pediatric patients by using the STRONGkids screening tool.

Methods: This was a cross-sectional study in which 350 consecutive pediatric patients were admitted to inpatient clinics. STRONGkids screening tool was used for the assessment of the risk of malnutrition. Data on age, sex, body weight, height, admission diagnosis, and the length of hospital stay were recorded. STRONGkids scores, standard deviation (SD) Z-scores of height-for-age and body mass index (BMI)-for-age were calculated for each participant.

Results: It is found that 37.7% of patients have high risk, 50.9% have moderate risk, and 11.4% have low risk of being malnourished. It is detected that 13.7% of patients have chronic malnutrition and 16.9% have acute malnutrition. The acute malnutrition of the patient group with high risk of becoming malnourished is significantly higher than those in the moderate- and low risk groups ($p<0.05$). The average length of hospitalization in high risk group (14.9±14.8 days) is relatively higher than that of low risk group (8.3±7.3 days) ($p<0.05$). No significant association was found between age and gender variables and malnutrition ($p>0.05$). The risk of malnutrition is higher among patients with respiratory failure, cancer, and burn injuries than other disease groups ($p<0.05$).

Conclusion: In order to prevent protein-energy malnutrition, it is important to assess the nutritional status of patients at the time of their hospital admission. STRONGkids is a highly practical, an easy-to-use, and a reliable screening tool for the assessment of risk of malnutrition.

Keywords: Malnutrition, Screening Tool for Risk of Impaired Nutritional Status and Growth (STRONGkids)

Introduction

Malnutrition is defined as a nutritional disorder, a combination of varying degrees of over- or undernutrition and inflammatory activity, which causes changes in the body composition and loss of body function (1). Growth is the best indicator of nutritional status, and the use of growth curves is the simplest way to assess the nutritional status in children (2). Malnutrition is a significant public health problem that can cause long-term damage or permanent disorders. It has significant effects on growth, morbidity and mortality, cognitive development, and economic productivity (3).

Hospitalized patients are one of the most vulnerable groups with an increased risk for malnutrition. The causes of malnutrition in inpatients include disease-related anorexia, difficulties in feeding, increased nutritional requirements, inadequate hospital diets, prolonged periods of fasting due to diagnosis and treatment procedures, and increased metabolic stress because of illness (4).

In order to prevent malnutrition in hospitalized patients, it is important to recognize the condition of these patients during their hospital admission. Various nutritional risk screening methods have been devised to increase the awareness of physicians and allied health professionals about the early recognition of malnutrition. Screening Tool for Risk of Impaired Nutritional Status and Growth (STRONGkids) is one of the most useful and easiest methods for the detection of malnutrition (5). This study was

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designed to determine the risk of malnutrition in hospitalized patients by using the STRONGkids screening tool and to investigate the factors that affect it.

Materials and Methods

Study subjects and design

This was a cross-sectional study in which 350 consecutive patients were admitted to inpatient clinics of Izmir Dr. Behcet Uz Children's Hospital (Izmir, Turkey) between September 2014 and March 2015 and were evaluated for eligibility for the study. The inclusion criteria were age>1 month and<18 years, and the length of hospitalization of >1 day. The patients were included in the study within 48 hours of hospital admission at the infant unit, toddler unit, burn care unit, general pediatric ward, surgery, nephrology, allergy, cardiology, hematology and oncology, endocrinology, infectious disease, neurology, and orthopedics wards. The exclusion criteria included age <1 month or >18 years, ≤1 day of length of hospitalization, and admission to the intensive care unit and emergency department.

The study protocol was approved by the Clinical Research Ethics Board of Erciyes University Medical Faculty (approval date and number: 01/08/2014, and 2014/481). The parents of all study participants were completed written informed consent forms before enrollment. The study was performed in accordance with the principles of the Declaration of Helsinki.

Screening Tool for Risk of Impaired Nutritional Status and growth

The STRONGkids is a screening tool developed by Hulst et al. (5) to predict the risk of malnutrition in hospitalized (>1 day) children aged between 1 month and 18 years. In this tool, four items, including subjective clinical assessment, high risk disease, the loss of nutritional intake, and weight loss, are used to produce a final score (Table 1).

If a patient's score is 4–5 points, malnutrition risk is considered high (high risk [HR]). Score of 1–3 and 0 points are considered as moderate (moderate risk [MR]), and low risk (low risk [LR]) for malnutrition, respectively (5).

In order to adapt STRONGkids to Turkish children, permission was granted from Hulst et al. (5) via e-mail. The translation into Turkish version was carried out in four stages. In the first stage, the STRONGkids questionnaire form was translated into Turkish by three independent translators. Secondly, a different translator evaluated these three translations and produced a Turkish text with the best representation of each of the four items. In the third stage, these items were evaluated by a medical committee involving one pediatric gastroenterologist, one hepatology and nutrition unit training supervisor, one pediatric cardiologist, three pediatric nephrology residents, two plastic and reconstructive surgeons, one pediatric surgeon, two pediatric endocrinologists, one pediatrist, one pediatric surgery resident, one dietitian, and seven pediatric nurses. As per their recommendations, the final Turkish text of these four items was created. Finally, this text was translated back to English by a different translator, and confirmed by Hulst et al. (5) (Figure 1). To evaluate interobserver agreement between the surveyors conducting the survey of STRONGkids, Pearson's chi-square test was used. The test showed a perfect match.

Data collection

The STRONGkids scores were calculated for each study participant. In addition, data on age, sex, body weight,

Table 1. STRONGkids scoring system

Items	Explanations	Points
Subjective clinical assessment	Is the patient in a poor nutritional status judged with subjective clinical assessment: loss of subcutaneous fat and/or loss of muscle mass and/or hollow face?	1
High risk disease	Is there an underlying illness with risk for malnutrition (see list) or expected major surgery?	2
Diminished nutritional intake	Is one of the following items present? ▪ Excessive diarrhea (≥5 times/day) and/ or vomiting (>3 times/day) during the last 1–3 days ▪ Reduced food intake during the last 1–3 days ▪ Pre-existing nutritional intervention (e.g., ONS or tube feeding) ▪ Inadequate nutritional intake because of pain	1
Weight loss	Is there a weight loss (all ages) and/or no increase in weight/height (infants <1 year) during the last few week–months?	1

height, the medical or surgical diagnosis of patients, and the length of hospital stay were recorded.

Patient characteristics

Patients were selected from different age groups. Age groups were arranged as follows: (1) 0–11 months, (2) 12–35 months, (3) 36–71 months, (4) 72–119 months, and (5) ≥ 120 months. Seventy-five consecutive patients were selected from each age group. So, in total, 375 patients were selected for the study. Twenty-five patients were excluded from the study due to various reasons including death, transfer to the intensive care unit, etc. Overall, 350 patients who fulfilled the inclusion criteria were finally included in the analysis.

Anthropometric measurements

Anthropometric measurements were made according to the recommendations of the World Health Organization (WHO) (6). A sensitive baby scale (with 0–20 kg±0.02 kg sensitivity) (Ex-8006, United Kingdom) was used for infants. To measure the height of infants, a sensitive stadiometer (with 10–80 cm±1 mm sensitivity) (F. bosch-fb100, Germany) was used with the infant in the supine position. For older children, a combined auto scale and stadiometer device (with 0–200 kg±100 g and 75–200 cm±1 mm sensitivity) (Tess Di-mk, Turkey) was used. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Standard deviation (SD) Z-scores of height-for-age and BMI-for-age were calculated by using Anthro (children≤5 years old) and AnthroPlus (children>5 years old) Software Program developed by the WHO (7, 8).

The determination of malnutrition

Patients who had <−2 SD Z-scores of height-for-age were considered as having chronic malnutrition whereas patients with <−2 SD Z-scores of BMI-for-age were considered as having acute malnutrition.

Statistical analysis

The conformity of data to normal distribution was checked by the Kolmogorov–Smirnov/Shapiro–Wilk test. For descriptive analysis, continuous variables were presented as mean ± SD, and categorical data results were presented as frequency and percentage. To compare categorical variables, Pearson's chi-square or Fisher's exact test was used.

To compare the groups in terms of measurement variables, the one-way ANOVA test was used. The homogeneity of variances was evaluated by Levene's test. While there was a significant difference between the groups, Fisher's least

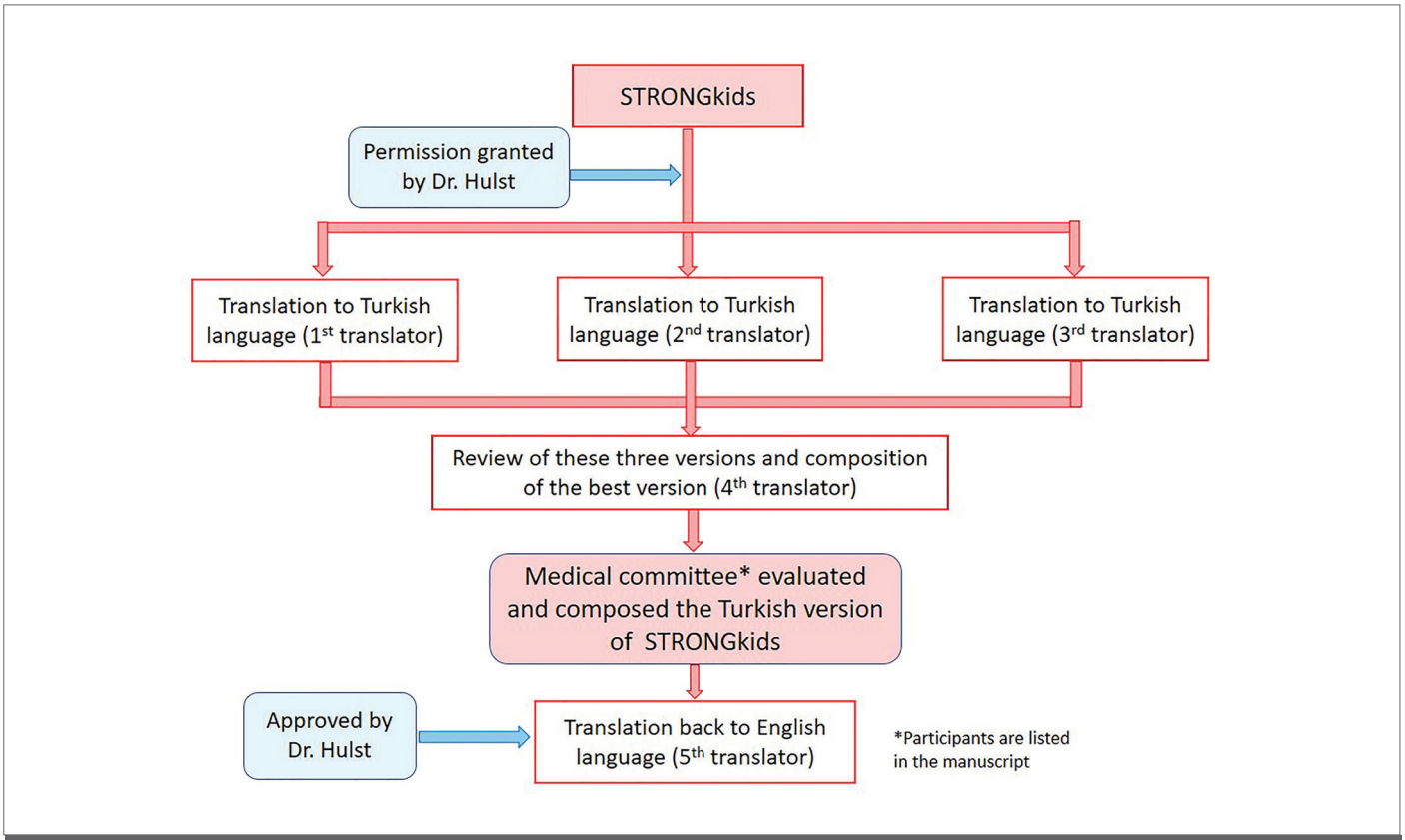

Figure 1. Methodology of the composition of the Turkish version of the STRONGkids

significant difference (LSD) method was used in two-way post-hoc comparisons if variances were homogeneous. If variances were not homogeneous, the Dunnett T3 test was used.

A receiver operating characteristic curve (ROC) analysis was used to determine the sensitivity and specificity of the groups with and without the risk of malnutrition. The correlation of nominal values was evaluated by Cramer's V measurement. P<0.05 was considered as statistically significant. The data were analyzed using the IBM Statistical Package for the Social Sciences (IBM SPSS Corp.; Armonk, NY, USA) version 17 software package.

Power analysis

According to the power analysis, to be able to detect the statistical significance of a 10% prevalence of "malnutrition" with 80% power, 5% type I error, and 5% effect size, at least 341 subjects were aimed to be included. Power analysis was performed by means of G*Power 3.1.9.4 for Windows (Open Source) package program.

Results

Patient characteristics

Of the study patients, 41.1% were girls, and there was no statistical difference between boys and girls (p>0.05). The distribution of number of patients according to age groups were as follows: 71 patients (20.3%) in 0–11 months, 73 patients (20.9%) in group 12–35 months, 65 patients (18.6%) in 36–71 months, 71 patients (20.3%) in 72–119 months, and 70 patients (20%) in ≥120 months group.

Anthropometrics measurements and Z-scores

Anthropometric measurements, Z-scores of height-for-age and BMI-for-age, and malnutrition frequency according to age group of patients are shown in Table 2. There was no significant difference between age groups in terms of the prevalence of acute and chronic malnutrition (p>0.05).

STRONGkids risk groups and the prevalence of malnutrition

According to STRONGKids, out of 350 patients, 132 (37.7%) patients had a high risk of malnutrition, 178 (50.9%) had a moderate risk, and 40 (11.4%) had a low risk.

The risk of malnutrition, according to the diagnosis of disease, is given in Table 3. The high risk for malnutrition rate in patients with an oncologic disease was found to be higher than that in patients with low risk and moderate risk malnutrition (p<0.0001). Similarly, the high risk for malnutrition rate in patients with respiratory disease was higher compared with the patients with low risk for malnutrition (p<0.0001). Moreover, the moderate risk for malnutrition was found to be higher in patients with an oncologic disease and burns than the low risk for malnutrition (p<0.05).

The risk of malnutrition according to age, sex, and the duration of hospitalization is shown in Table 4. The mean age was 79.3±63.4 months for the high risk for malnutrition patients, 55.7±52.9 months for the moderate risk patients, and 76.4±62.8 months for the high risk patients (p=0.003).

The mean length of hospital stay was 14.9±14.8 days in patients with the high risk for malnutrition, 11.7±12.2 days in patients with moderate risk, and 8.3±7.3 days in patients with low risk. The length of hospital stay was significantly higher in patients with the high risk for malnutrition than that of patients with low risk (p=0.05). However, there was no significant difference with respect to the length of hospital stay between the patients with moderate risk and the other two risk categories (p>0.05).

Table 2. Anthropometric measurements, Z-scores of height-for-age and BMI-for-age of the patients and malnutrition frequency according to age groups

	Anthropometric measurements			Z-scores		Malnutrition status	
Age groups (months)	Weight (g)	Height (cm)	BMI (kg/m²)	Height-for-age	BMI-for-age	Acute malnutrition	Chronic malnutrition
0–11 (n=71)	6799.3±2476.7	63.6±8.8	16.2±2.6	−0.7539	−0.2932	11 (15.5%)	12 (16.9%)
12–35 (n=73)	11475.6±4555.1	83.4±10.8	16.1±2.2	−0.2037	−0.1485	12 (16.4%)	10 (13.7%)
36–71 (n=65)	16700.8±3972.8	104.1±9.2	15.4±2.7	−0.1275	−0.1725	8 (12.3%)	5 (7.7%)
72–119 (n=71)	24281.1±7306.8	122.4±17.1	19.7±32.1	−0.3973	−0.2373	13 (18.3%)	9 (12.7%)
≥120 (n=70)	46324.3±159484	153.6±17.6	19.2±4.9	−0.5606	−0.2899	15 (21.4%)	12 (17.1%)
Total (n=350)	21077.3±162579	105.2±34.1	17.4±12.9	−0.4126	−0.2288	59 (16.9%)	48 (13.7%)

BMI: body mass index

The relationship between the STRONGkids risk groups and the occurrence of type of malnutrition is given in Table 5. The rate of acute malnutrition was found to be significantly higher in patients with high risk for malnutrition as compared with the moderate- and low risk groups (p=0.0001). However, there was no statistically significant difference between the moderate- and low risk for malnutrition groups in terms of the rate of acute malnutrition (p>0.05).

ROC analysis of STRONGkids for malnutrition risk

The sensitivity and specificity values of the STRONGkids scoring system for the determination of acute and chronic malnutrition are given in Table 6. As sensitivity and specificity analysis was performed, patients were divided into two groups, as being with and without risk for malnutrition, according to the STRONGkids scores. The patients with the high and moderate risk for malnutrition were considered as risk-positive groups, whereas the patients with the low risk for malnutrition were considered as risk-negative group. The sensitivity, specificity, positive predictive value, and negative predictive value of STRONGkids to predict the presence of acute malnutrition were 100%, 13.75%, 19.03%, and 100%, respectively. For chronic malnutrition, sensitivity, specificity, positive predictive value, and negative predictive value were 91.6%, 11.92%, 14.19%, and 90%, respectively.

ROC analysis of length of hospital stay for malnutrition risk

The cut-off value of the length of hospital stay between the patients with and without malnutrition risk was ≥6.5 days. The sensitivity and specificity of STRONGkids to differentiate the length of hospital stay between these two groups were 67.8% and 52.5%, respectively. C-statistics analysis revealed that the area under the curve value was 0.556 (p<0.005).

Table 3. The risk of malnutrition of the patients according to the diagnosis

Diagnosis	Low risk (n)	Moderate risk (n)	High risk (n)	Total (n)
Respiratory disease	9 (11.7%)	46 (59.7%)	22 (28.6%)	77
Oncological disease	0 (0%)	16 (22.9%)	54 (77.1%)	70
Burn	0 (0%)	28 (71.8%)	11 (28.2%)	39
Neurological disease	5 (13.5%)	23 (62.2%)	9 (24.3%)	37
Trauma	0 (0%)	0 (0%)	2 (100%)	2
Infectious disease	7 (29.2%)	15 (62.5%)	2 (8.3%)	24
Surgical operation	6 (26.1%)	11 (47.8%)	6 (26.1%)	23
Cardiological disease	0 (0%)	4 (30.8%)	9 (69.2%)	13
Gastrointestinal disease	1 (9.1%)	4 (36.4%)	6 (54.5%)	11
Nephrological disease	1 (10%)	5 (50%)	4 (40%)	10
Endocrinological disease	3 (30%)	7 (70%)	0 (0%)	10
Metabolic disease	0 (0%)	0 (0%)	5 (100%)	5
Others	8 (27.6%)	19 (65.5%)	2 (6.9%)	29

Table 4. The risk of malnutrition according to the age, sex, and duration of the hospitalization

	Low risk	Moderate risk	High risk	Total	p
Age (months)	79.3±63.4	55.7±52.9	76.4±62.8	66.3±58.9	0.003*
Length of hospital stay (days)	8.3±7.3	11.7±12.2	14.9±14.8	12.5±12.9	0.008*
Sex (n, %)					
Female	19 (13.2)	76 (52.8)	49 (34)	144 (41.1)	0.422**
Male	21 (10.2)	102 (49.5)	83 (40.3)	206 (58.9)	

*ANOVA; **Pearson's chi-square test.

Table 5. The relationship between STRONGkids risk groups and acute/chronic malnutrition occurrence					
Type of malnutrition	**High risk (n, %)**	**Moderate risk (n, %)**	**Low risk (n, %)**	**Total (n, %)**	**p**
Acute malnutrition					
Negative	86 (65.2)	165 (92.7)	40 (100)	291 (83.1)	0.0001*
Positive	46 (34.8)	13 (7.3)	0 (0)	59 (16.9)	
Chronic malnutrition					
Negative	97 (73.5)	169 (94.4)	36 (90)	302 (86.3)	0.0001*
Positive	35 (26.5)	9 (5.1)	4 (10)	48 (13.7)	
*Pearson's chi-square test.					

Table 6. Sensitivity and specificity values of STRONGkids scoring system on determination of the acute and chronic malnutrition			
Analysis	**Value (%)**	**Confidence interval 95%**	**p**
Acute malnutrition			
Sensitivity	100.00	93.94–100.00	<0.05*
Specificity	13.75	10.01–18.24	
Negative predictive value	19.03	14.82–23.85	
Positive predictive value	100.00	91.19–100	
Chronic malnutrition			
Sensitivity	91.60	80.20–97.68	<0.05*
Specificity	11.92	8.49–6.12	
Negative predictive value	14.19	10.51–18.58	
Positive predictive value	90.00	76.34–97.21	
*Pearson's chi-square test.			

Discussion

Unlike adults, impaired nutrition in childhood causes both weight loss and malnutrition. Exposure to factors associated with malnutrition may lead to severe and permanent disorders when malnutrition occurs during the childhood (9). It has been shown that the short stature in children is most common among the age group of 24–35 months. Approximately, 3% of the children aged 48–59 months was found to be stunted in Turkey (10). Durakbasa et al. (11) reported that the malnutrition rate is higher in children under 5 years of age. In our study, no difference was observed between the age groups in terms of acute and chronic malnutrition.

Generally, hospitalized patients have the highest risk of malnutrition (12). Malnutrition also affects the success of the treatment of a particular disease (13). To prevent hospital-acquired malnutrition and its complications, nutritional deficiency and the risk of malnutrition should be identified in a timely fashion, especially during admission to a hospital (14). STRONGkids is one of the methods used for this purpose (5). Early detection of malnutrition helps prevent irreversible developmental disorders in pediatric patients. A systematic review conducted in 2018 showed that STRONGkids had a predictive capacity to detect the risk of malnutrition correctly. The ideal method for assessing nutritional status should be both sensitive and specific so as not to be affected by factors unrelated to nutrition. STRONGkids is one of these methods that takes the subjective evaluation of patients, the presence of high risk comorbid disease, nutrient intake, weight loss, or weight gain into consideration (15).

The prevalence of malnutrition has been reported up to 50% in hospitalized pediatric patients in Turkey. This rate is fairly high compared with that in European countries (16, 17). In our study, malnutrition was detected in 30.6% of the whole study cohort. While the prevalence of acute malnutrition was 16.9%, the prevalence of chronic malnutrition was 13.7%. According to STRONGkids, the prevalence of high risk for malnutrition was 37.7%, moderate risk was 50.9%, and low risk was 11.4%.

In a study from Turkey, the authors reported that the high risk for malnutrition was 1.2%, the moderate risk was 34.5%, and the low risk was 64.6% in pediatric surgical patients according to STRONGkids (11). In our surgical patients, these values for high-, moderate-, and low risk category were 26.1%, 47.8%, and 26.1%, respectively. In a latter study, the authors also found the rate of malnutrition as 13.4%, acute malnutrition as 10.1% (more commonly in patients aged ≤60 months than aged >60 months) and chronic malnutrition as 4.6%, with no significant difference between the age groups. In a multicenter study from Turkey, Beser et al. (18) demonstrated that the high risk for malnutrition was more common in patients with a chronic disease. They also reported the acute and chronic malnutrition rates as 11.2% and 16.6%, respectively. In the same vein, we found acute malnutrition rate as 16.9% and chronic as 13.7%. Although many studies have reported various results, it can be expected that the rate of malnutrition is higher in the developing countries (15).

While the nutritional status of an individual might affect the functions of the respiratory system and increase the risk of respiratory failure, respiratory diseases per se might cause malnutrition (19, 20). Pathophysiological mechanisms of malnutrition in patients with chronic lung disease involve impaired gastrointestinal system function, insufficient nutrient intake, maladaptive mechanisms to minimize oxygen consumption, impaired cardiac function, and hypermetabolic status (19). Consistent with these facts, we also found the high risk for malnutrition in patients with respiratory disease higher (28.6%) than that in the patients with low risk for malnutrition.

The presence of infection can aggravate malnutrition or trigger development of de novo malnutrition (21). Negative nitrogen balance due to fever may cause malnutrition (21, 22). In our study, the high risk for malnutrition in patients with infection was 8.3%.

Cao et al. (23) reported that the risk of malnutrition in respiratory, oncologic, and cardiac diseases is higher than that in other groups. Similarly, we found the high risk for malnutrition is higher in patients with oncologic and respiratory diseases. Malnutrition occurs for a shorter period in children than adults because of the low proportion of fat and, thus, the lack of energy reserves in their bodies. Hence, malnutrition frequently develops in pediatric patients with cancer, especially during chemotherapy (24, 25).

In the literature, it has been shown that the length of hospital stay was higher in patients with the high risk for malnutrition (5, 18, 23, 26). In addition, a positive correlation between the risk of malnutrition and the length of hospital stay was reported (18, 26). In our study, the length of hospital stay was significantly higher in patients with the high risk for malnutrition than that in the low risk group.

In agreement with several studies, besides, we did not find any significant difference in terms of the risk of malnutrition among different age groups (5, 23, 26). Although most of the studies showed no relationship between the age and the risk of malnutrition, conflicting results have been reported regarding the same (15, 18, 26). Cao et al. (23) found that children aged 0–1 years had a higher risk of malnutrition than other age groups.

There are some limitations of our study. First, we used only one screening tool; thus, we could not compare other tools in this study. Secondly, the number of patients in the respective age groups was relatively low, but the total number of patients was sufficient according to the power analysis.

The salient findings of the present study are as follows: 1) The rate of acute malnutrition was found to be significantly higher in patients with the high risk for malnutrition compared with the moderate- and low risk groups, 2) the length of hospital stay was longer in patients with the high risk for malnutrition than that of low risk groups, 3) the cut-off value of length of hospital stay between the patients with and without risk for malnutrition was ≥6.5 days, 4) the rate of high risk for malnutrition in patients with an oncologic disease was found to be higher than low- and moderate risk groups, and 5) the high risk for malnutrition in patients with respiratory disease was higher than that in the patients with the low risk for malnutrition.

The present study is also important in terms of translating this screening tool into Turkish version and involving different patient groups in the study.

In conclusion, STRONGkids is a simple, an easy-to-apply, and a cheap method to detect the risk of malnutrition in children admitted to the hospital. STRONGkids scoring seems sufficiently sensitive and specific to detect malnutrition in hospitalized children.

Studies with a greater number of subjects are needed to confirm our encouraging findings in this study.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Erciyes University School of Medicine (01/08/2014-2014/481).

Informed Consent: Written informed consent was obtained from the parents of the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – B.O., N.İ.; Design – B.O., N.İ.; Supervision – N.İ.; Resources – B.O.; Materials – B.O.; Data Collection and/or Processing – B.O.; Analysis and/or Interpretation – B.O.; Literature Search – B.O.; Writing Manuscript – B.O.; Critical Review – N.İ.; Other – B.O., N.İ.

Conflict of Interest: The authors have no conflicts of interest to declare.

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