Original article

Determination of Malnutrition Risk in Paediatrics Patients With Two Screening Tools: Is Pyms or Strongkids Effective?

Eda Başmısırlı[1], Habibe Şahin[2], Meltem Soylu[3], Neriman İnanç[1], Mustafa Kendirci[4]

[1]Department of Nutrition and Dietetics, Faculty of Health Sciences, Nuh Naci Yazgan University, Kayseri, Turkey; [2]Department of Nutrition and Dietetics, Faculty of Health Sciences, Erciyes University, Kayseri, Turkey; [3]Department of Nutrition and Dietetics, Faculty of Health Sciences, Biruni University, İstanbul, Turkey; [4]Department of Paediatrics Endocrinology, Faculty of Medicine, Erciyes University, Kayseri, Turkey;

Abstract. *Aim:* Early diagnosis of malnutrition is important in hospitalized children. Since the effectiveness of screening tools is still unclear, this study was conducted to assess the risk of malnutrition with PYMS and STRONGkids in inpatients children and to compare them with their anthropometric measurements. *Material and Methods:* In this cross-sectional study, the risk of malnutrition was determined by PYMS and STRONGkids in 222 patients aged from 1 to 16 years old. *Results:* According to the BMI values of the patients, 84.7% were normal and 15.3% were acute malnourished. Severe and moderate stunting was detected 8.1% and 11.3% of chronic malnourished patients respectively. In the patients without acute malnutrition, the low malnutrition risk was found 55.0% of the patients with PYMS whereas 42.9% with STRONGkids. The detection rate of the moderate risk with STRONGkids (47.1%) was higher than those PYMS (22.2%). The detection rate of high malnutrition risk with PYMS (22.8%) was higher than those STRONGkids (10.1%). In the patients with acute malnutrition, PYMS could not detect low and moderate malnutrition risk. The detection rates with STRONGkids were 6.1% for low and 36.4% for moderate risk. STRONGkids' ability to detect patients with high malnutrition risk was lower (58.3%) than that of PMYS (100%). Significant changes were determined between the patients with low, moderate and high malnutrition risk regarding anthropometric measurements by STRONGkids ($p<0.001$). *Conclusions:* According to anthropometric measurements, PYMS was superior for detecting acute malnutrition while STRONGkids was superior for detecting chronic malnutrition.

Key words: anthropometry, malnutrition risk, PYMS, STRONGkids, screening Tools

Introduction

Although malnutrition includes both inadequate and excessive nutrition concepts, mortality and morbitide rates are higher in malnourished patients due to inadequate nutrition (1). According to the data of the World Health Organization (WHO), malnutrition is the main underlying reason for approximately 45% of all child mortality below 5 years of age (2). It has been reported that the prevalence of disease-related malnutrition ranges from 6% to 30% in hospitalized children in Europe (3,4). This wide prevalence interval may result from the inconsistency of the criteria used for describing the disease-related malnutrition in pediatrics patients (3). Moreover, failure in the detection of malnutrition or malnutrition risk by health professionals is also an important factor. Pause in growth or slow growing, increased susceptibility to various infections as well as prolonged hospital stay are among the complications associated with malnutrition (5).

Early diagnosis of malnutrition is thought to be important in hospitalized children to prevent complications. Therefore, the need for early detection of malnutrition has led to the development of various nutritional screening tools. Today, seven screening tools are available for detecting malnutrition in children admitted to hospital (4). In previous studies, it has been reported that Pediatric Yorkhill Malnutrition Score (PYMS) and Screening Tool For Risk of Impaired Nutritional Status and Growth (STRONGkids) have higher sensitivity and specificity compared to other screening tools developed for the early detection of malnutrition (6–10). When the results of previous studies (7–13) were evaluated, it can be seen that the two screening tools appear to differ in determining the risk of malnutrition in acute and chronic forms of malnutrition. It has been determined that the STRONGKIDS screening tool detects all of the children with acute malnutrition (16/16) whereas the PYMS screening tool identified 13 out of 16 patients (9). In a study of Moeeni et al. (8), it has been determined that the STRONGkids screening tool detects a higher number of moderate acute malnutrition patients than the PYMS screening tool whereas the PYMS screening tool detects a higher number of severe acute malnutrition patients than the STRONGkids. In another study, when the kappa values were taken as the basis, the PYMS screening tool was better adapted to acute malnutrition than the STRONGkids screening tool (10).

The study aimed at revealing the risk of malnutrition with STRONGkids in pediatrics patients has been encountered in Turkey (14). Since the effectiveness of screening tools is still unclear, this study was conducted to assess the risk of malnutrition with PYMS and STRONGkids in hospitalized children and to compare them with anthropometric measurements.

Materials and Methods

This cross-sectional study was conducted to determine the risk of malnutrition by PYMS and STRONGkids and to compare the obtained data to anthropometric measurements in 222 patients with a median age of 8.1 (ranged from 1 to 16) years old hospitalized at Erciyes University Mustafa Eraslan and Fevzi Mercan Children's Hospital (Kayseri/TURKEY) between 20/05/2015 and 25/12/2015 with the permission of Erciyes University Clinical Research Ethics Committee (approval no: 2014/670 and date: 05.12.2014).

Because the PYMS screening tool can be implemented for children between one and 16 years of age, volunteers between one and 16 years old were included in the study within at least 48 hours after admission to the hospital. Because the patients are under 18 years of age, the parents of the children were informed about the study in accordance with by the Helsinki Declaration and volunteers were asked to sign the Informed Volunteer Consent Form thus informed verbal consent was obtained from the parents of all the children involved in the study. Patients needing intensive care, having malignant disease, being <1 year old and >16 years old were not included in the study. The sample size was calculated as 217 people by taking into account of the rate of malnutrition in Turkey (18.4-40.9%) by using MedCalc program with 95% confidence level ($\alpha = 0.05$), with 80% power ($\beta = 0.20$) and with ±9% error (15,16).

The demographic characteristics of the patients were recorded on the questionnaire through face to face interviews with the attendants by the researcher. The questionnaire form consisted of questions about the patient's initial and family names, the service, file and room number, pre-diagnosis, anthropometric measurements (body weight, height, skinfold thickness, upper middle arm circumference and wrist circumference), date of birth, gender and length of hospital stay of the patient.

Anthropometric measurements

The BMIs of the patients were calculated by measuring their body weight with a scale (BC-533- Tanita, Japan) and their height with a height meter (MZ0017 Height Meter - Tanita, Japan). In addition, mid-upper arm circumference (MUAC) were measured with a tape measure, triceps and biceps skinfold thickness were measured with a caliper (Holten Skinfold Caliper). Measurements of children under five years old were performed in the mother's lap (17).

Determination of Malnutrition

Children having a risk of malnutrition were identified with PYMS (18) and STRONGkids (12) within the first 48 hours after at least one day of hospitalization. The heights and body weights of the patients were measured and whether they were malnourished or not regarding anthropometric measurements were determined by the Z-score (17). "Height for age (HFA)" and "Body Mass Index (BMI) for age" were determined by using the WHO Multicentre Growth Reference Study (MGRS) 2006 and 2007 growth chart (19). The standard deviation values of BMI for age between -2 and -3 were defined as moderate acute malnutrition and standard deviation values below -3 were accepted as severe acute malnutrition. Standard deviation values of height for age between -2 and -3 were defined as stunting and standard deviation values below -3 were accepted as severe stunting (3).

PYMS

The PYMS scan tool consisted of five steps. In the first step, the height and weight of the child were measured and the BMI was calculated. If the result was less than the limit of the child's age, it was scored as two points. In the second step, the weight loss in recent times was questioned. If the answer was "No" a score of zero was given, if the answer was "Yes" (unintended weight loss, the unfitted clothes, inadequate weight gain), 1 point was given. In the third step, the following question " Was there a decrease in food intake of the child in the last week?" was asked. If the answer was "No", the score was zero and if the answer was "Yes (the food intake was lower than regular intake in the last week)", 2 points were given. In the fourth step, the question "Will the food intake of the child be affected by his/her condition within the next week?" was asked. If the answer was "No", the score was zero and if the answer was "Yes (decreased food intake and/or increased requirements and/or increased losses in the next week)" 1 point or "Yes (no food intake or a few sips)" 2 points were given. In the fifth step, points from four steps were added. The results 0, 1 and 2 or more were considered as "Low risk", "Moderate risk" and "High risk" respectively (18).

STRONGkids

The other screning tool, STRONGkids, consisted of four sections. These sections are subjective global assessment (1 point), high disease risk (2 points), nutrient intake and loss (1 point) and body weight loss or increase (1 point). In this screening tool, each section was scored by 1 or 2 points through the scan, and the highest risk score was determined as 5. The standard deviation values of weight for height below -2 were defined as acute malnutrition and standard deviation values of height for age below -2 were defined as chronic malnutrition. Later on, the relationship between the results of the screening tools and the anthropometric measurements were determined and 1 - 3 points were defined as moderate malnutrition risk, and 4 - 5 points were considered as high malnutrition risk (12).

The patients with low, moderate and high risk of malnutrition were determined with the PYMS and STRONGkids screening tools and the results were compared with anthropometric measurements. In addition, the compatibility of the scanning tools with each other was evaluated by kappa analysis and accordingly the kappa values were determined. Kappa values 0.01-0.20, 0.21-0.40, 0.41-0.60, 0.61-0.80 and 0.81-1.00 were considered as "insignificant", "weak", "moderate", "good" and "very good" level of compliance (20).

Statistical Evaluation of Data

The data were analyzed with Statistical Package for Social Sciences for Windows (SPSS) 22.0 package program. The normality of the data was tested by the Shapiro-Wilk test. A Chi-squared test was used to determine the difference between the categorical variables. One-way ANOVA was used to compare groups. The homogeneity of variance was assessed by the Levene test. When the differences between groups were significant the two-tailed Post-Hoc comparisons were done. When the variances were homogeneous, Tukey was used and when the variances were not homogeneous, Dunnett's T3 test was performed. The compatibility between the screening tests was evaluated by kappa analysis. A value of $p < 0.05$ was considered statistically significant.

Results

The 55.9% (n = 124) of the patients were male and 44.1% (n = 98) were female out of 222 patients with a median age of 8.1 (ranged from 1 to 16) years old. According to the BMI values, 84.7% of the patients were within the normal BMI limits and 15.3% were with acute malnutrition (moderate malnutrition in 9.5% and severe malnutrition in 5.8%). Severe stunting was 8.1% whereas moderate stunting was 11.3% detected of chronic malnourished patients (Table 1).

Table 1. Distribution of Malnutrition Status According to Anthropometric Measurements of Patients

Acute Malnutrition	**n**	**%**
No malnutrition (BMI>-2 SD)	188	84.7
Moderate Malnutrition (BMI < -2, >-3 SD)	21	9.5
Severe Malnutrition (BMI < -3 SD)	13	5.8
Chronic Malnutrition	**n**	**%**
No malnutrition (HFA > -2 SD)	179	80.6
Moderate stunting (HFA < -2, >-3 SD)	25	11.3
Severe stunting (HFA <-3 SD)	18	8.1
Total	**222**	**100**

In patients without acute malnutrition, the low malnutrition risk was found in 55.0% of the patients with PYMS whereas in 42.9% of the patients with STRONGkids. The detection rate of the moderate risk with STRONGkids (47.1%) was higher than the rate of PYMS (22.2%). PYMS revealed a high malnutrition risk at a higher rate than STRONGkids (22.8% and 10.1% respectively) in patients without acute malnutrition. On the other hand, in patients with acute malnutrition, patients with low and moderate risk of malnutrition were unidentified with PYMS, whereas 6.1% and 36.4% of patients were found to have low and moderate risks, respectively, with STRONGkids. In addition, STRONGkids' ability to detect patients with a high risk (58.3%) in acute malnutrition was found to be lower than that of PYMS (100%). The differences between PYMS and STRONGkids were found statistically significant ($p < 0.05$) considering the detection rate for low, medium and high risk in children with acute and chronic malnutrition (Table 2).

According to PYMS, body weight, BMI, wrist circumference and mean Z-score of the patients with high malnutrition risk were significantly lower than the patients with low and moderate malnutrition risks ($p<0.05$). Compare to patients with low malnutrition risk, the height, triceps and biceps skinfolds and mean

Table 3. Comparison of risk rates determined by PYMS and STRONGkids screening tools in the presence of acute and chronic malnutritions risk

	Acute Malnutrition Absent		**Acute Malnutrition Present**		**Chronic Malnutrition Absent**		**Chronic Malnutrition Present**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
PYMS								
Low	**104**	**55.0**	**0**	**0.0**	**90**	**50.3**	**14**	**32.6**
Moderate	**42**	**22.2**	**0**	**0.0**	**37**	**20.7**	**5**	**11.6**
High	**43**	**22.8**	**33**	**100**	**52**	**29.1**	**24**	**55.8**
Total	**189**	**100**	**33**	**100**	**179**	**100**	**43**	**100**
	$x^2 = 75.341, p = 0.000$				$x^2 = 10.293, p = 0.006$			
STRONGkids								
Low	**81**	**42.9**	**2**	**6.1**	**75**	**41.9**	**8**	**18.6**
Moderate	**89**	**47.1**	**12**	**36.4**	**89**	**49.7**	**12**	**27.9**
High	**19**	**10.1**	**19**	**57.6**	**15**	**8.4**	**23**	**53.5**
Total	**189**	**100**	**33**	**100**	**179**	**100**	**43**	**100**
	$x^2 = 40.38, p = 0.000$				$x^2 = 40.473, p = 0.000$			

Z-score of the patients with a high malnutrition risk were low with the PYMS ($p<0.05$). Statistically significant differences were determined between the patients with low, moderate and high malnutrition risks regarding body weight, height, BMI, triceps and biceps skinfolds, MUAC, and wrist circumference Z-scores by STRONGkids ($p<0.001$) (Table 3).

In the compatibility test, the kappa value was found as 0.70 thus there was a good consistency between the two tests. Both screening tools categorized 119 people in the high-risk category. According to the STRONGkids screening tool, 28 patients were found to have high risk of malnutrition while PYMS screening tool found these patients at low risk. PYMS screening tool revealed 6 patients with high-risk, whereas according to the STRONGkids screening tool, these patients were found in the low-risk category. Both screening tools revealed that 80 patients were at low malnutrition risk (Table 4).

Table 3. Detected malnutrition risk values of the patients with PYMS, STRONGkids and anthropometric measurements

	PYMS				STRONGkids			
	Low risk n= 108	**Moderate risk n= 47**	**High risk n= 77**		**Low Risk n= 86**	**Moderate risk n= 106**	**High risk n= 40**	
Z-scores	$\bar{X} \pm SS$	$\bar{X} \pm SS$	$\bar{X} \pm SS$	***p***	$\bar{X} \pm SS$	$\bar{X} \pm SS$	$\bar{X} \pm SS$	***p***
Body weight	$0.35^{a} \pm 0.93$	$0.05^{b} \pm 0.86$	$-0.51^{c} \pm 0.72$	**	0.47 ± 0.91	-0.06 ± 0.80	-0.86 ± 0.56	**
Height	$0.19^{d} \pm 0.90$	$0.05^{e} \pm 0.96$	$-0.29^{f} \pm 0.88$	*	0.33 ± 0.95	0.002 ± 0.83	-0.72 ± 0.70	**
BMI	$0.36^{g} \pm 0.85$	$0.07^{h} \pm 0.87$	$-0.54^{ı} \pm 0.80$	**	0.42 ± 0.88	-0.09 ± 0.81	-0.66 ± 0.87	**
Triceps skinfold	$0.25^{j} \pm 0.92$	$-0.01^{k} \pm 0.97$	$-0.35^{l} \pm 0.80$	**	0.37 ± 0.90	-0.07 ± 0.88	-0.63 ± 0.75	**
Biceps skinfold	$0.26^{m} \pm 0.92$	$0.06^{n} \pm 0.93$	$-0.40^{o} \pm 0.81$	**	0.38 ± 0.88	-0.08 ± 0.91	-0.60 ± 0.68	**
MUAC	$0.31^{p} \pm 0.91$	$-0.003^{r} \pm 0.78$	$-0.42^{s} \pm 0.86$	**	0.48 ± 0.85	-0.12 ± 0.80	-0.73 ± 0.85	**
Wrist circumference	$0.23^{t} \pm 0.93$	$0.10^{u} \pm 0.89$	$-0.37^{v} \pm 0.84$	**	0.38 ± 0.86	-0.08 ± 0.84	-0.61 ± 0.93	**

*:p<0.01, **:p<0.001
There is a significant difference between a and c, b and c.
There is a significant difference between d and f.
There is a significant difference between g and ı, h and ı.
There is a significant difference between j and l.
There is a significant difference between m and o.
There is a significant difference between p and r, between p and s, and between p and s.
There is a significant difference between t and v, u and v.

Table 4. Cross classification of malnutrition risk detected with PYMS and STRONGkids

	STRONGkids		
PYMS	**High risk (n)**	**Low risk* (n)**	**Total (n)**
High risk (n)	112	6	118
Low risk* (n)	27	77	104
Total	139	83	222
Sensitivity (%)	81		
Specificity (%)	93		
Positive predictive value (%)	95		
Negative predictive value (%)	74		
False negative Ratio (%)	19		
False positive ratio (%)	7		

*Moderate and high risk categories were grouped in the same group.

Discussion

Early detection of nutritional insufficiency is important for preventing hospital malnutrition, and proper nutritional intervention depending on correct diagnosis can prevent malnutrition (13,21). The thoughts for early detection of malnourished children have led to the development of various nutritional screening tools. However, the data is inadequate concerning the use of these tools in the clinic and the degree of consistency between nutritional tools, and there is no consensus on which tool should be used (22). Therefore, this study was conducted on hospitalized pediatrics patients (n=222), mean aged 8.1 (1-16) years old with the aims of determining hospital malnutrition risk with PYMS and STRONGkids, and comparing the results obtained with these two new screening tools with anthropometric measurements.

According to the 2002 guidelines of The European Society for Clinical Nutrition and Metabolism (ESPEN), there is no universally accepted screening method for children. In the standard application that is currently used, there are height and body weight graphics (23). These graphs are evaluated with clinical results. However, the reliability of this practice varies depending on the knowledge of the pediatrician or the pediatrics dietitian about pediatrics nutrition. The detection of severe malnutrition or severe malnutrition risk can be relatively easy compare to moderate or mild malnutrition or their risks. However, it may not be possible to easily detect moderate or mild malnutrition or risks (21).

In a study comparing STAMP, STRONGkids and PYMS, the STRONGkids screening tool revealed all children (16/16) with severe and moderate malnutrition according to anthropometric measurements but PYMS (13/16) and STAMP (15/16) were unable to identify all. Thus, these authors have suggested that all of these screening tools can be used to identify children at nutritional risk, but the STRONGkids screening tool is more reliable (9). In another study using STAMP instead of PYMS, STRONGkids was found to correlate with all anthropometric measurements, and it was emphasized that the STRONGkids screening tool may be a more useful screening tool than STAMP in determining pediatrics nutritional status (7). In our study, all children with acute malnutrition were categorized as high risk group by PYMS whereas STRONGkids was able to reveal only 57.6% of the children as high risk. Conversely, in the presence of chronic malnutrition, STRONGkids screening tool identified 81.4% (moderate risk 27.9%, high risk 53.5%) whereas the PYMS tool was able to detect 67.4% (moderate risk 11.6%, high risk 55.8%) of the patients. These results suggest that PYMS may be more useful in determining acute malnutrition and STRONGkids in determining chronic malnutrition (Table 3). Similarly, in another study, STRONGKIDS and PYMS screening tools were compared and STRONGKIDS screening tool was reported to be more sensitive than PYMS for detecting chronic malnutrition (8).

In the evaluation of anthropometric measurements in children and adolescents, the use of percentile values for the assessment of the individuals and Z-scores and, if necessary, percentile values for community assessments have been suggested (24). Similar to the present study, Moeeni et al. (9) used both screening tools, STRONGkids and PYMS, and found a negative correlation between BMI Z-scores and the two screening tools. However, in another study by Moeeni et al. (8), both STRONGkids and PYMS screening tools correlated with height for body weight Z-scores, but only the STRONGkids screening tool correlated with also the Z-scores of height for age. These authors reported that the STRONGkids screening tool was more sensitive than PYMS for detecting chronic malnutrition.

Cao et al. (25) found that patients with a high risk of malnutrition had significantly lower mean z scores for body weight, height, BMI and MUAC than the patients with low and moderate malnutrition risks by using the STRONGkids screening tool. In this study, Z-scores of anthropometric measurements (body weight, BMI, wrist circumference) were also found to be significantly lower solely in the high-risk patients than in the patients with low- and moderate-risks by PYMS whereas significant decreases were determined in all groups by STRONGkids. In the other anthropometric measurements (height, triceps and biceps skinfolds), there was a significant difference only between the high-risk group and the low-risk group by PYMS; again significant decreases were determined in all groups by STRONGkids. This suggests that compared to anthropometric measurements, STRONGkids may be superior to PYMS

in terms of especially height, an indicator of chronic malnutrition. Consistent with the results of Cao et al. (25) the mean Z-scores of all anthropometric measurements were reduced with the increasing malnutrition risk compare to low and moderate risk (Table 3).

As previously indicated that STRONGKIDS and PYMS were more sensitive and specific than other screening tools in the early detection of malnutrition (6–10), the high sensitivity and specificity of these two screening tools used in our study were due to the very low false negative (19%) and positive rates and (7%) (Table 4). The only study that investigated kappa compliance analysis showed that the agreement between STRONGkids and PYMS screening tools was poor (kappa = 0.270) in patients with inflammatory bowel disease (26). However, in the present study, the compatibility of the screening tools was high (kappa = 0.70).

Conclusion

Considering the complications associated with malnutrition, length of hospitalization and impact on health expenditures, it is necessary to determine the malnutrition as soon as possible before taking precautions. Detection of malnutrition in a short time is only possible with routine nutritional screening. Therefore, even if malnutrition is determined by anthropometric measures, the likelihood of high risk should be demonstrated in patients with low and moderate risks using rapid and easy screening tools and nutritional support should be provided immediately. The results of present study have shown that according to anthropometric measurements, PYMS was superior for detecting acute malnutrition while STRONGkids screening tool was superior for detecting chronic malnutrition. However, further investigations are needed for the confirmation of these findings for generalization.

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Correspondence:
Eda Başmısırlı
Nuh Naci Yazgan Üniversitesi Yerleşkesi Erkilet Dere Mah.
Kocasinan/KAYSERİ
E-mail: edabasmisirli@gmail.com
Phone: 0 (352) 324 00 00 / 5255
Fax: 0 (352) 324 00 00