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Evaluation of malnutrition development risk in hospitalized children

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ABSTRACT

Objectives: Many screening methods, such as the Screening Tool Risk on Nutritional Status and Growth (STRONGkids) and the Pediatric Yorkhill Malnutrition Score (PYMS), have been developed to detect malnutrition in pediatric patients. We aimed to explore the prevalence of malnutrition risk in hospitalized children via symptoms and identification of contributing factors, and to examine the efficacy of malnutrition screening tools for hospitalized children.

Methods: STRONGkids and PYMS were applied to 1513 inpatients at 37 hospitals in 26 cities from different regions of Turkey. Physical measurements were collected at hospital admission and at discharge. z-Scores of height-for-age, weight-for-age, weight-for-height, and body mass index–for–age were calculated.

Results: Overall, 1513 patients were included in the study. A body mass index standard deviation score of less than –2 was present in 9.5% of the study population at hospital admission, whereas 11.2% of the participants had a weight-for-length/height score of less than –2 at hospital admission. According to STRONGkids results, the proportion of the patients with an underlying chronic disease was higher for the patients at high risk of malnutrition than for the patients at medium or low risk (91% compared with 47% or 45%, respectively). PYMS results indicated that patients at high risk of malnutrition have more chronic diseases (75%) than the patients at medium or low risk of malnutrition (55% and 44%, respectively).

Conclusions: Use of anthropometric measurements in addition to screening tools to identify hospital malnutrition (such as PYMS, STRONGkids) will prevent some nutritional risk patients from being overlooked.

Introduction

The development of malnutrition is potentially high in hospitalized children for several reasons, including the increased energy need as a result of the current disease, decreased appetite connected with the underlying disease and concomitant drug use, and neglected diet during the treatment of the disease [1,2]. Different prevalence rates have been reported for pediatric malnutrition, particularly undernutrition, in various countries around the world. High acute and chronic malnutrition percentages in different countries have been reported [3–5]. Small scale and local studies [6,7] from Turkey have also reported high prevalence rates (31.8% [6] and 27.7% [7]). Although most studies have reported the prevalence of undernutrition at admission to a hospital, a considerable number of children develop undernutrition during their hospital stay. Only a few studies have evaluated the development of undernutrition in children during hospital stays. These studies indicate that nutritional status deteriorates in 5% to 27%

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of children after admission to a hospital [8,9]. An early risk determination of the development of undernutrition in children can avoid or diminish nutrition-associated complications and prolonged hospitalization [10,11]. The European Society for Clinical Nutrition and Metabolism [12], the American Society for Parenteral and Enteral Nutrition [5,13], and the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition [14] recommend a nutritional screening, which is rapid and simple, to determine the patients who are nutritionally at risk. The main objective of the nutritional screening is to detect a condition at an early point in which the treatment is more effective and/or less expensive [15]. Several validated pediatric nutrition risk screening tools were reported to be effective in identifying children at risk of malnutrition development [14,16,17].

This is the first study that employed screening tools (Screening Tool Risk on Nutritional Status and Growth [STRONGkids] and the Pediatric Yorkhill Malnutrition Score [PYMS]) and anthropometric measurements to determine the malnutrition frequency in hospitals and related factors that affect children throughout Turkey.

The first aim of our study was to compare the nutritional status of the patients via anthropometric measurements at the time of admission to the hospital stay and to identify the related factors. The second aim was to determine the anthropometric changes during the hospitalization and compare these changes with the patient characteristics. The third aim of our study was to determine the results of the PYMS and STRONGkids screening tools and to match them to the anthropometric measurements with the factors affecting them during a hospital stay. In this scope, STRONGkids and PYMS scorings were performed for all patients at the time of hospitalization and at discharge. The evaluation of these tests together has never been reported in the literature. The main reason for this evaluation was to identify the relationship of the changes in STRONGkids and PYMS scores (progression, if any) with the patient characteristics and anthropometric measurements during hospitalization.

Materials and methods

Participants

This prospective, observational, multicenter study was conducted in 37 secondary and tertiary health care centers, located in 26 cities within 12 statistical regions of Turkey. The study was conducted between March and July 2015 by 66 investigators from the TÜHAMAR[1] Study Group. We obtained the hospitalization data of all pediatric hospitals in Turkey from the Turkish Statistical Institute (Ankara, Turkey) to determine the required number of participants to achieve statistically significant results for the study. The sample size calculation was based on a hypothetical prevalence of malnutrition, estimated at 12.3% present on admission, for otherwise healthy children in Turkey, a country of approximately 77 million people at the time of study commencement. The study planned to enroll a minimum of 1255 patients, with an acceptable difference in prevalence of 6.1% and a confidence interval of 95%. The recruiting hospitals were selected in cities that were representative of the geographic regions of Turkey. The number of patients enrolled in each city was calculated based on overall population and hospitalization rate at each selected representative city.

Patients (1 mo to 18 y old) who were admitted to pediatric wards with an anticipated length of stay >24 h were eligible to participate. Patients were consecutively invited to participate in the study whenever data collection was possible within the first 24 h after admission. Patients who attended to the accident and emergency department of the day care unit were excluded from the study. We excluded critically ill children who were admitted to intensive care units because of the limited feasibility to perform detailed anthropometric measures on the day of admission. We also excluded children admitted to the day care hospital because their expected length of hospital stay (LOSs) was <24 h. The patients who received steroids and other appetite stimulant drugs or enteral nutrition treatment during the previous 3 mo because of malnutrition were not included in the study because these factors may affect the rates of malnutrition. Patients with cerebral palsy or genetic disorders were not excluded in the protocol. Details about the recruitment and protocol have been previously published by Hecht et al [18].

Parents or caregivers were informed about the nature of the study with a detailed information sheet. The total amount of expenditure required for basic needs such as clothing, housing (rent, electricity, water, fuel), transportation, education, health and similar basic necessities along with food is defined as the poverty limit. Based on this poverty limit, which was determined by official authorities of Turkey, families that were below the poverty line were defined as family with low monthly income. Written informed consent was provided by the parents of each hospitalized patient. This study protocol was approved by the Ethics Committee of Istanbul University, Cerrahpaşa Medical School Ethics Committee on January 9, 2015.

Anthropometry, measurements for assessment of nutritional status, and nutritional risk factors

On admission (screening visit), demographic (age and sex) and social environmental characteristics of the enrolled children were recorded, including the collection of data for body weight, height, detailed presenting symptoms, medical history, and the reason for hospitalization, which was classified as acute or chronic diseases. Socioeconomic status and medical history of the patients' families were also recorded.

Weight, height, and length were measured using methods previously described by the World Health Organization (WHO) [19]. All scales and stadiometers were calibrated at each site before the study commencement. Measurements were performed using the same standardized Conformité Européene marked scales and stadiometers (freely digital scale with stadiometer; Desis-M 101 B scale with stadiometer; Seca 201 circumference measuring tape; all Conformité Européene marked) in all 37 study hospitals to ensure that all centers adhered to the same standards. All the measurements were performed two times, in the first 24 h after admission (screening visit) and at discharge, by the same physician at the center. After measuring the weight, height, and length of the entire study population, 4 different z-scores (height-for-age [HFA], weight-for-age [WFA], weight-for-length/height [WFL/H], and body mass index–for–age [BMI]) were calculated using the WHO Anthro program (Version 3.2.2, January 2011) for children 5 y of age or younger. For children aged older than 5 y, the BMI-for-age (children ages 5–19 y), height-for-age (children ages 5–19 y), and weight-for-age (children ages 5–10 y) z-scores were calculated using the WHO AnthroPlus Software.

The risk for malnutrition was evaluated using the STRONGkids questionnaire [9], which was developed and validated for screening the nutritional status of children between the ages of 1 mo and 18 y old. The STRONGkids questionnaire was conducted twice, at admission and discharge. At the same time, the risk for malnutrition during hospitalization for children ages 1 to 16 y was also evaluated with a second screening test, the PYMS [20]. Important characteristics of the PYMS and STRONGkids are reported in Supplemental Table S1.

The PYMS includes anthropometric measures (BMI compared with weight and height, respectively), whereas STRONGkids includes a subjective clinical assessment of nutritional status. The total scores for each tool were computed for those age groups with validated tools. PYMS was completed for patients ages 1 to 16 y, and STRONGkids was completed for patients ages 1 mo to 18 y. Only the children ages 1 to 16 y were considered for the comparison of the 2 tools because the patients within this age range were eligible for screening by both tools. The total score and classification of malnutrition risk (low, moderate, or high) were determined for each study participant by screening tools. The scores obtained by the 2 screening tools were then correlated to the anthropometric measures, body compositions, and outcome data.

Statistical analyses

Participants were separated into age groups of 1 to 12 mo, 13 to 48 mo, 49 to 84 mo, 84 to 144 mo, and greater than 144 mo for the analyses. Sensitivity and specificity were calculated using results from screening tools divided into low risk and moderate to high risk of malnutrition. Statistical analyses were performed using SPSS Software Version 18.1 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as percentages and were compared using either Fisher's exact test for two groups or χ^2 tests for three or more groups. Continuous variables were presented as medians with interquartile ranges and were compared using the Kruskal-Wallis non-parametric test or the Mann–Whitney *U* two-sample test. McNemar's test has been used for evaluation of repeating measures for the same individual and for the calculation of *P* value. Spearman's correlation was used to assess the relationships among anthropometric data and STRONGkids and PYMS tool outcomes. The significance level was set at <0.05.

[1] Evaluation of malnutrition development risk in hospitalized children in Turkey (**TÜ**rkiye'de**HA**stanede Yatan Çocuklarda **M**alnutrisyon**AR**aştırması) Study Group.

Results

Patient characteristics

Overall, 1513 patients were included in the study (median age: 4.4 y). Nearly half of the study population was male (56.4%), and 47.5% of the participants had an underlying chronic disease. The median LOS was 6.0 d.

The number of participants in all five age groups was relatively evenly distributed, with a higher number of participants ($n = 389$; 25.7%) in the 12 to 48 mo age group and a lower number of participants ($n = 229$; 15.1%) in the 48 to 84 mo age group.

More than one-third (36.9%) of the children's families were poor. A total of 665 families (43.6%) had three or more children, and 57 families (3.8%) lived together in only one room.

Comparison of anthropometric measurements at the hospital admission with patient characteristics

At the time of admission 14.8% of the participants had a WFA standard deviation score (SDS) of less than –2. A total of 83% of these patients were younger than 5 y of age and 17% were 5 to 10 y of age. According to WFL/H SDS score at the hospital admission, which is only applicable for children 1 to 5 mo of age, the rate of the participants with a score of –2 was 11.2%, whereas the rate of the patients with scores of –1 or lower was 23.4%. A BMI SDS was calculated for patients 2 to 18 y old. BMI SDS score, which provides valuable information on malnutrition especially in patients older than 5 y of age, was less than –2 in 9.5% of the study population. Whereas 21.3% of these patients were 2 to 5 y of age, 78.7% were 5 to 18 y of age. When BMI SDS was evaluated only for patients older than 5 y, the rate of patients less than –2 was 10.4%, and this ratio corresponds to acute malnutrition according to BMI. On the other hand, 16.6% of the patients had HFA SDS less than –2, which is an indication of chronic malnutrition. A total of 65.7% of these patients with chronic malnutrition were younger than 5 y of age, 11.6% were 5 to 10 y of age, 22.7% were 10 to 18 y of age.

Patients with low income level and a high number of siblings were noted to have statistically high WFA SDS scores of –2 ($P < 0.001$ and $P = 0.010$, respectively).

Nearly 75% (74.1%) of the patients with WFL/H SDS ratios less than –2 and 61.9% of those with WFA SDS scores of –2 during hospitalization were children younger than 2 y of age.

The underlying chronic disease prevalence rates and the LOS were significantly higher ($P < 0.001$) in the patients with WFL/H, HFA, and WFA SDS less than –2 during hospitalization (Table 1).

Comparison of the PYMS and STRONGkids results with the patient's characteristics at the hospital admission

The number of eligible children for PYMS and STRONGkids varied because these screening tools were developed for different age ranges. STRONGkids and PYMS were applied two separate times, at the hospital admission and during the hospitalization. In total, 1099 participants completed the PYMS (the targeted group from 1 to 16 y of age), whereas 1513 participants completed STRONGkids (the targeted group from 1 mo to 18 y of age).

Use of different tools in the classification of the malnutrition risk of the children produced a substantial variation within the first 24 h of admission (screening visit) and at discharge from the hospital (Fig. 1).

Characteristics of the children within the risk groups of each screening tool at the hospital admission are described in Table 2.

The STRONGKIDS results indicated that the proportion of the high malnutrition risk patients with an underlying chronic disease was higher than the patients with a medium or low risk (91% compared with 47% or 45%, respectively). On the other hand, PYMS analyses indicated different results than those of STRONGKIDS. The prevalence of the underlying chronic disease was higher for the high-risk malnutrition patients than for the patients with medium or low risk (75% compared with 55% or 44%, respectively). The LOS increased from low- to high-risk patients as identified through the use of the 2 tools (Table 2).

On the other hand, we examined the specificity and sensitivity of the STRONGkids and PYMS screening tools for determining acute malnutrition at the time of admission separately for BMI, WFL/H, and WFA Z scores. In patients 1 to 5 mo of age, according to WFL/H SDS, STRONGkids had a sensitivity of 72.2% and a specificity of 93.0%, whereas PYMS had a sensitivity of 89.4% and a specificity of 96.9%. In patients 5 to 18 y of age, according to BMI SDS, STRONGkids had a sensitivity of 72.3% and a specificity of 94.8%, whereas PYMS had a sensitivity of 87.8% and specificity of 97.3%. In patients 1 mo to 10 y of age, according to WFA SDS, STRONGkids has a sensitivity of 70.3% and specificity of 90.3, whereas PYMS had a sensitivity of 86.6% and specificity of 95.4%.

Risk categorization and anthropometric measures

According to each tool assessment, mean SDSs for either BMI, WFL/H, WFA, or HFA differed among the three risk groups

Table 1
Comparison of patient characteristics with WFL/H, HFA, and WFA SDS values at hospital admission

	WFL/H SDS ($n = 805$)			WFA SDS ($n = 1116$)			HFA SDS ($n = 1513$)		
	≤–2	>–2	*P*	≤–2	>–2	*P*	≤–2	>–2	*P*
Female	9.50	90.50	0.401	14.10	85.90	0.782	17.30	82.70	0.82
Male	12.40	87.60		15.30	84.70		16.10	83.90	
Age, mean (y)	1.27	1.18	0.507	2.26	3.97	0.014	6.1	4.6	0.108
LOS									
≤3 d (%)	5.90	94.10	0.021	7.80	92.20	0.001	10.50	89.50	0.002
>3 d (%)	12.40	87.60		16.50	83.50		18.10	81.90	
Acute disease ($n = 795$)	8.20	91.80	<0.001	8.80	91.20	<0.001	10.90	89.10	<0.001
Chronic disease (n = 718)	16.30	83.70		23.80	76.20		22.80	77.20	

HFA, height-for-age; LOS, length of hospital stay; SDS, standard deviation scores; WFA, weight-for-age; WFL/H, weight-for-length/height.
χ^2, Mann–Whitney *U*.

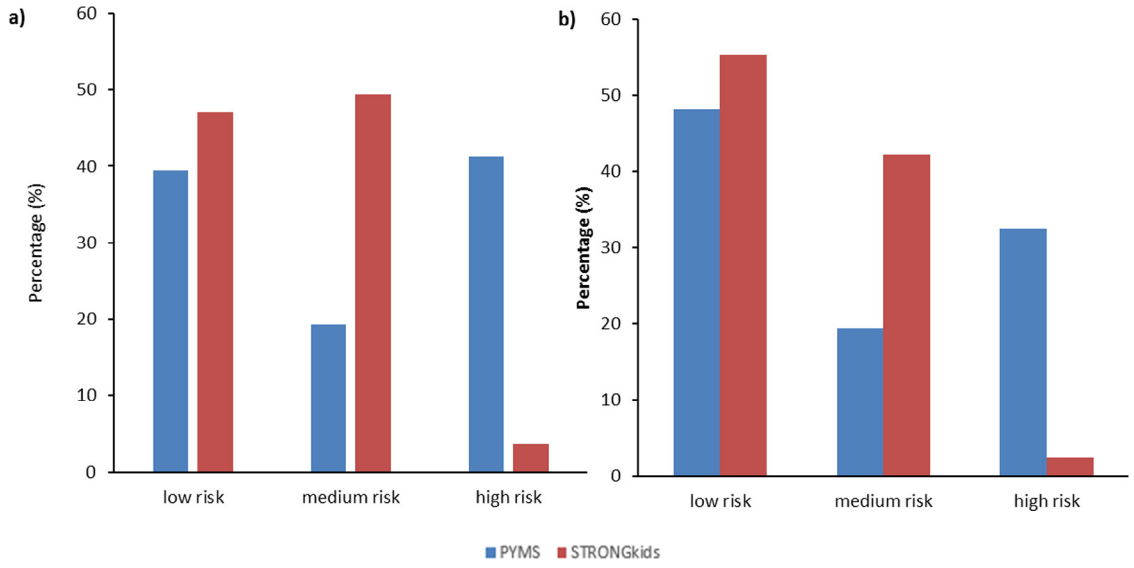

Fig. 1. Malnutrition risk classification based on the two screening tools expressed: (A) at admission, and (B) at discharge, as percentages of the total number of assessed children for each tool. PYMS, Pediatric Yorkhill Malnutrition Score; STRONGkids = Screening Tool for Risk of Impaired Nutritional Status and Growth.

(Table 2). Additionally, a considerable number of children with low SDS (less than –2) were categorized in either the low- or medium-risk category. Table 3 shows the relevant differences in the results of the two selected tools for the group of children who completed the questionnaire and had available BMI data. Although 26% of the patients had a BMI SDS value less than –2, they were not identified as the high-risk group in STRONGkids evaluations. On the other hand, the PYMS scores of all patients, whose values were less than the BMI SDS –2 at the hospital admission, were categorized in the high-risk group.

Table 2
Characteristics of children within the risk groups of each screening tool

	STRONGkids (1 mo to 18 y old; $n = 1513$)			PYMS (1–16 y old; $n = 919$)		
	Low ($n = 712$)	Medium ($n = 747$)	High ($n = 54$)	Low ($n = 377$)	Medium ($n = 177$)	High ($n = 365$)
Age, y	5	3.9	4.6	7.9	6.4	7.3
Age group (%)						
31 d–0.9 y	20	24	30	NA	NA	NA
1–3.9 y	25	27	18	20	28	23
4–6.9 y	15	15	17	24	27	25
7–11.9 y	19	16	9	29	28	27
12–17.9 y	21	18	26	27	17	25
Female (%)	42	45	50	42	50	44
Acute admission (%)	55	53	9	56	45	25
Chronic disease (%)	45	47	91	44	55	75
LOS	6	7	10	6	6	7
BMI SDS	–0.32	–0.48	–1.18	0.01	–0.04	–0.73
WFA SDS	–0.12	–0.57	–2.69	0.15	0.03	–0.85
HFA SDS	–0.46	–0.65	–2.34	–0.33	–0.56	–0.82
WFL/H SDS	0.32	–0.2	–1.92	0.59	0.43	–0.63

BMI, body mass index–for–age; LOS, length of hospital stay, NA, non-analysis; PYMS, Pediatric Yorkhill Malnutrition Score; SDS, standard deviation score; STRONGkids, Screening Tool Risk on Nutritional Status and Growth; WFA, weight-for-age; WFL/H, weight-for-length/height.

Table 3
BMI SDS within the risk groups for two malnutrition-risk screening tools

BMI SDS	STRONGkids (2–18 y old; $n = 981$)			PYMS (2–16 y old; $n = 908$)		
	Low ($n = 489$)	Medium ($n = 431$)	High ($n = 61$)	Low ($n = 367$)	Medium ($n = 176$)	High ($n = 365$)
At least –1 SDS (n)	420	331	12	331	154	228
Less than –1 to at least –2 SDS (n)	61	92	4	36	22	66
–2 or less SDS (n)	8	8	45	0	0	71
–2 or less SDS and not categorized in the high-risk group (% n)	26 (16of61)			0 (0of71)		

BMI, body mass index–for–age; PYMS, Pediatric Yorkhill Malnutrition Score; SDS, standard deviation score; STRONGkids Screening Tool Risk on Nutritional Status and Growth.

Table 4
Evaluation of anthropometric measurements during the hospitalization period

Groups	WFL/H SDS			WFA SDS			BMI SDS		
	n = 794			*n* = 1102			*n* = 984		
	Decreasing*	Not decreasing†	*P*	Decreasing*	Not decreasing†	*P*	Decreasing†	Not decreasing†	*P*
	n = 304	*n* = 490		*n* = 594	*n* = 508		*n* = 449	*n* = 535	
Age (mean y)	1.3	1.2	0.3	3.5	3.9	0.102	4.8	5	0.4
Female, %	41	43	0.56	44	43	0.862	47	44	0.34
Z score decrease average (mean)	–0.44			–0.25			–0.34		
Acute disease (%)	39	61	0.49	48	52	0.08	46	54	0.56
Chronic disease (%)	37	63		58	42		45	55	
LOS, mean (d)	9.3	5.8	0.02	8.1	6	0.05	8.6	5.5	0.03
STRONGkids									
Low	45	43	0.48	45	43	0.22	50	50	0.92
Medium	50	53		50	53		46	47	
High	5	4		5	4		4	3	
PYMS									
Low	32	47		35	50		21	16	
Medium	27	34	0.02	25	35	0.02	38	42	0.03
High	41	19		40	15		41	42	

BMI, body mass index–for–age; LOS, length of hospital stay; PYMS, Pediatric Yorkhill Malnutrition Score; SDS, standard deviation score; STRONGkids Screening Tool Risk on Nutritional Status and Growth; WFA, weight-for-age; WFL/H, weight-for-length/height.
χ^2, Mann–Whitney *U*.
* Decreasing group is composed of participants with a 3% decrease in SDS during discharge from the hospital.
† Not-decreasing group composed of participants with <3% decrease, any increase, or no change in SDS score during hospitalization.

Determination of the anthropometric changes during hospitalization

Evaluation of anthropometric measurements during hospitalization and SDS calculations were performed for all our patients during the hospital admission and discharge. Thirty-eight percent of the patients' WFL/H, 54% of the patients' WFA, and 46% of the patients' BMI SDS were decreased more than 3% at discharge, compared with the hospitalization period, and the decreased Z-score average (mean) values were –0.44, –0.25, and 0.34, respectively.

LOS was determined to be longer for those patients with the 3% reduction in WFL/H, WFA, and BMI SDS values (decreasing group as given in Table 4; $P = 0.02$, 0.05, and 0.03, respectively) at the time of discharge, compared with the patients without the significant changes in these three parameters. When we evaluated these patients further, the PYMS score at the time of admission was high in the decreasing group, and the relationship was statistically significant ($P = 0.02$, 0.02, and 0.03 for the WF/H, WFA, and BMI SDS, respectively). However, there was no statistically significant relationship between the initial STRONGkids score of the decreasing group at admission and the high STRONGkids score at discharge ($P = 0.48$, 0.22, and 0.92 for the WFL/H, WFA, and BMI SDS, respectively). Table 4 summarizes the results of the anthropometric changes during the hospitalization period.

Evaluation of STRONGkids and PYMS scores at admission and discharge

The STRONGkids and PYMS scores were compared when patients were hospitalized and discharged.

The clinical characteristics of the low- and/or medium-risk patients whose condition had a progression (worsening; increased STRONGkids and PYMS scores) during discharge were compared with those who had no progression (conditions remained stable or got better). Patients with progressed (worsening; increased STRONGkids and PYMS scores) STRONGkids and PYMS scores had a higher prevalence of chronic disease ($P = 0.001$ and $P = 0.01$, respectively) and had longer LOS ($P = 0.047$ and $P = 0.007$, respectively; Table 5).

A decrease was noted in the BMI SDS value (at the time of discharge) of 55.1% of the patients with increased PYMS scores at discharge, whereas this decrease was identified in only 39.3% of the patients with not-increased PYMS scores at discharge. The difference was statistically significant ($P < 0.001$). A decrease was noted in the BMI SDS value (at the time of discharge) of 73.3% of the patients with increased STRONGkids scores at discharge, whereas this decrease was noted in only 42.8% of the patients with not-increased PYMS scores at discharge. The difference was statistically significant ($P < 0.001$).

Discussion

This is the first study to simultaneously employ screening tools (STRONGkids and PYMS) and anthropometric measurements to determine the hospital malnutrition frequency and the related factors affecting children throughout Turkey. Our study aimed to determine the nutritional conditions of the patients via anthropometric measurements at hospital admission and to define the related concomitant factors throughout the study.

SDSs –2 or less for WFL/H and HFA were indicators of acute and chronic malnutrition, respectively [9]. We found the acute malnutrition rate to be 11.2% and the chronic malnutrition rate to be 16.6%. Previous small-scale and local studies performed in Turkey found higher acute malnutrition rates (31.8% [6] and 27.7% [7]) when weight for height parameter was used and the cutoff value is accepted as –2. In these studies, patients with z-scores less than –1 were accepted as having acute malnutrition, whereas we accepted z-scores less than –2 as acute malnutrition. We believe that the primary reason for reported higher rates was related to the use of different parameters for assessing the nutritional status of the patients. As in our study, Hulst et al. [9] used the WHO scoring system in the WFL/H and HFA SDS calculations. They found a similar ratio to our study for acute malnutrition and a lower ratio than our study for chronic malnutrition (11% and 9%, respectively). As in previous studies [9,21,22], most of

Table 5
Comparison of patient characteristics with the progression of STRONGkids and PYMS scores at hospital admission and discharge

	STRONGkids Score			PYMS Score		
	Increased (n = 132)	Not increased (n = 1381)	P	Increased (n = 391)	Not increased (n = 708)	P
Female (%)	43.2	43.7	0.915	43.50%	42.70%	0.792
Age groups (%)						
0–12 mo	19.7	22.6	P*	—	—	P*
12–48 mo	33.3	25		39.6	33.1	
48–84 mo	10.6	15.6		19.4	21.6	
84–144 mo	15.2	17.3		23.1	23.9	
>144 mo	21.2	19.5		17.9	21.4	
Hospitalization time						
≤3 d (%)	n = 17 (12.9%)	n = 278 (20.1%)	0.047	n = 64 (16.4%)	n = 165 (23.3%)	0.007
>3 d (%)	n = 115 (87.1%)	n = 1103 (79.9%)		n = 327 (83.6%)	n = 543 (76.7%)	
Acute diseases (%)	n = 55 (41.7%)	n = 740 (53.6%)	0.001	186 (47.6%)	352 (49.7%)	0.01
Chronic diseases (%)	n = 77 (58.3%)	n = 641 (46.4%)		205 (52.4%)	356 (50.3%)	

PYMS, Pediatric Yorkhill Malnutrition Score; STRONGkids, Screening Tool for Risk of Impaired Nutritional Status and Growth.
χ^2 logistic regression.
* No statistically significant difference was observed when we compared the change in STRONGkids or PYMS scores with each of the age groups.

the patients were younger than 2 y of age, and they had a longer LOS, with a higher rate of chronic illnesses. In our study, we also found that the patients with acute and chronic malnutrition at hospital admission had more siblings, and their family income level was low.

We also determined the outcomes of PYMS and STRONGkids screening tests and the factors influencing them in hospitalized patients. As illustrated in Figure 1, STRONGkids and PYMS scores at discharge were lower than those during the hospitalization. The reason for this declining trend can be related to the elimination of the risk factors by curing the disease and better nutritional support during hospitalization. On the other hand, evaluation performed with the STRONGkids screening tool, which was performed both at the time of admission and discharge, indicated that more patients were at medium risk when compared with the evaluation performed with PYMS. Similarly, the STRONGkids tool evaluated many fewer patients in the high-risk group compared with the PYMS tool. The ratios of patients in medium- and high-risk groups were not similar according to PYMS and STRONGkids scoring systems. This study found marked differences in the number of patients who could be screened with the use of the two tools. Also, the scores and classification of malnutrition risk in children varied substantially according to the tool used. Incompatible results were found between these two screening tools in the study by Chourdakis et al. [21], which was conducted in European countries. A lack of agreement may be explained by the fact that the tools are different, although they contain similar steps. Although several components within the tools are similar, there are discrepancies in the scoring, duration of recall history, and approaches used to assess body size. In addition, the PYMS include anthropometric measures, whereas the STRONGkids focuses on identifying children at nutritional risk on admission by visual inspection of body habitus alone.

For each tool, we found a negative correlation between malnutrition risk and body composition and a positive correlation with the LOS. According to the assessments with each tool, children who were categorized as being at a high risk of malnutrition had a longer hospital stay. The correlation between the risk score classification and the LOS was the strongest with the STRONGkids and PYMS. However, the best benchmark for assessing the value of a screening tool remains a topic of discussion. Chourdakis et al. [21] reported a significant correlation between the screening score of nutrition risk screening tools and the LOS in children, but the LOS may also be influenced by many non-nutritional factors. However, adverse effects of malnutrition and the influence of the underlying disease interact, and both affect the LOS, which should be considered when assessing the relationship between risk scores and secondary outcomes, such as fever or the use of antibiotics.

We found that patients with high STRONGkids and PYMS scores were at a higher risk of having the chronic underlying disease, despite having low WFL/H, WFA, HFA, and BMI SDS values. Therefore, patients with high STRONGkids or PYMS scores during admission to the hospital should be followed up more carefully in terms of nutrition during hospitalization.

Screening tools aim to identify children at risk of deterioration of malnutrition risk as a result of an acute medical insult despite a normal anthropometric measure at hospital admission. This identification helps to prevent and identify weight loss, which is probably as important as the weight loss correction and growth catch-up in malnourished children [23].

We evaluated whether the PYMS and STRONGkids scoring during hospital admission could detect high-risk patients (–2 or less SDS) according to the anthropometric measurements. Although 26% of the patients had a BMI SDS –2 or less, they were not identified in the high-risk group using the STRONGkids measurements. Additionally, all patients who had BMI SDS values –2 or less were in the high-risk group according to PYMS scores at hospital admission (Table 4). Because the anthropometric measurements are used in the PYMS scoring during hospital admission, these patients, who initially have SDS scores less than –2 SDS, can be accepted to a high-risk group. Even though it is easier and more practical to use STRONGkids, when anthropometric measurements are not done, some patients in this type of high-risk group may be missed at the time of admission [24]. The malnutrition of patients during hospitalization was determined by comparing the anthropometric measurements of the admission and the discharge. We found that the patients with decreasing WFL/H and WFA SDS values more than 3% during the discharge (decreasing group) had higher PYMS scores and LOS was longer when compared with those without lower scores of all three parameters. The most important reason for not observing the same correlation with STRONGkids scoring is related to the anthropometric measurements, which are only done for PYMS. However, it should be noted that neither screening tool can always detect the SDS declines of some patients during discharge.

All patients had STRONGkids and PYMS scorings done at the time of hospitalization and discharge. The factors associated with changes in STRONGkids and PYMS during hospitalization were determined. As a result, we did not identify any differences in terms of age and sex when we analyzed the patients with increased STRONGkids and PYMS scores during discharge from the hospital. However, we found that patients with increased scores according to both screening tools had more chronic illnesses, and their LOS was longer. We believe that the main reasons for progression in the discharge PYMS and STRONGkids scores include several factors, such as the increased frequency of complications in patients with chronic diseases and long hospitalizations, the decrease in the recovery rate of the primary disease, and the fact of the overlooked nutritional status of the patient during hospitalization. Certainly, these data are not sufficient to suggest administration of each screening tool twice (at admission and discharge); however, we detected that the BMI SDS values are further reduced in patients with increased scores at the time of discharge compared with admission.

The high diagnostic diversity prevented us from identifying risk factors statistically. On the other hand, the decrease in BMI SDS between hospitalization and discharge was higher in patients with progression in PYMS and STRONGkids scores, and the decrease in BMI SDS in patients with no progression was lower. In this case, especially in patients with chronic illnesses and long hospitalization histories, we believe that obtaining these scores during hospitalization and discharge may be beneficial for the recognition and early intervention of patients at risk for malnutrition.

This study also has some limitations. First of all, we wanted to determine the frequency of malnutrition in hospitalized children and the factors that affect them throughout the country. For this reason, we used the data that were available at the Turkish Statistical Institute. However, we could not determine the disease subgroups with the available data, so we did not have the opportunity to present the related analyses. On the other hand, we were not able to examine and present the data on the nutritional support given to our malnourished patients because we were unable to obtain an ethical approval of our work from the local ethical committee, allowing a nutritional intervention. Moreover, with our data, we could not determine the effects of disease groups or severity on the correlation between malnutrition risk and clinical outcomes. The power to detect nutrition-associated infections was limited because of the generally short LOS of the patients, which reflects current clinical practice. Despite the mentioned limitations of our study, we strongly believe that we obtained unbiased and important information on malnutrition development risk in hospitalized children throughout Turkey with relatively large data sets.

In conclusion, we recommend that every child hospitalized for any reason, whether for acute or chronic disease, be carefully evaluated during admission to the hospital by WFL/H measurements together with one of the scoring systems (PYMS or STRONGkids). We believe that using only a screening tool, without doing WFL/H measurements, may result in overlooking some patients at risk of malnutrition. On the other hand, if supported by other studies, we think that identification of the patient with progression by applying screening tools during both hospitalization and discharge may be beneficial in recognizing the patients at risk of malnutrition.

The risk of malnutrition increases during hospitalization, especially if there is a chronic underlying disease that has been prolonged LOS. Therefore, this subgroup of patients should be even more carefully evaluated and monitored during their hospital stay.

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Supplementary data

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