A Retrospective Comparison between the PNST and other Paediatric Nutritional Screening Tools

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Abstract: *Background*: Although it is widely acknowledged that hospitalized children are at greater risk of malnutrition, the available paediatric Nutritional Risk Screening (NRS) tools have not yet become universally used to identify those children at greater risk. Furthermore, the utility of one NRS tool over another remains unclear.

Materials and Methods: The utility of a recently developed tool, the Paediatric Nutritional Screening Tool (PNST), was evaluated using data previously collected in the assessment of three other NRS tools in 281 children from Iran and New Zealand. The sensitivity and specificity of each tool was then assessed based on the WHO criteria for malnutrition.

Results: The PNST recognized about half of the malnourished patients while the other three tools identified at least 85% of these children. The sensitivity of PNST for moderate (BMI-z $\leq$ 2) and severe malnutrition (BMI-z <-3) was 37% and 46% respectively, while the sensitivity for other three NRS tools ranged from 82-100%.

Conclusion: In this data set, the PNST tool did not perform as well as the three more established NRS tools. Further work is required to provide optimal tools for the identification of hospitalized children at risk of malnutrition.

Keywords: Malnutrition, Nutritional risk screening, paediatrics, children, hospital admission.

INTRODUCTION

Children who require hospitalization are at greater risk of malnutrition during their hospital stay [1]. Early detection and management of those children who are at risk of malnutrition, could prevent deterioration and adverse outcomes. Several screening tools have been developed for the assessment of the nutritional status of paediatric inpatients in recent years. These include the Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP) [2], Screening Tool for Risk On Nutritional status and Growth (STRONGkids) [3], Paediatric Yorkhill Malnutrition Score (PYMS) [4] and more recently, the Paediatric Nutritional Screening Tool (PNST) [5]. The four tools and their components are summarised in Supplementary Appendix 1. The goal of these screening tools is to provide a rapid evaluation to identify children at risk of deterioration of their nutritional state during their hospitalization. Identification may then enable to introduction of a specific nutritional intervention. Given the associations between malnutrition and nutritional risk with factors such as prolonged length of hospital stay, appropriate interventions may decrease morbidity and also reduce hospitalization-related costs.

While the PNST was developed in Australia, the other three tools were developed in European countries. The PNST is composed of four questions: these ask about recent unintentional weight loss, poor weight gain, loss of appetite or poor feeding and if the child is obviously under or overweight. The PNST was reported to be more sensitive, valid and simpler than other paediatric tools [5], but comparative analyses have not yet been performed.

This retrospective study aimed to compare the sensitivity and specificity of the PNST with that of the STRONGkids, STAMP and PYMS tools. This comparative analysis utilised previously collected data from a large group of children assessed upon their admission to hospital.

METHODS

Study Design and Subjects

The PNST tool scores were generated from a data set comprising 281 children aged between 12 months and 17 years (median age 5.3 yrs) at their admission to paediatric hospitals in Iran [6] or New Zealand [7]. As the study group was not normally distributed, median values were used for each demographic parameter. As previously described in detail, these two cohorts of children had been assessed with regards their nutritional status at the time of hospitalization. In addition, their risk of nutritional deterioration was previously assessed utilising the STRONGkids, PYMS and STAMP tools.

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Classification of Malnutrition

The World Health Organisation (WHO) classification was considered for recognition of malnutrition [8]. Children with weight-for-height (WFH) or height-for-age (HFA) <-3 z-score were considered severely malnourished. Moderate malnutrition was defined as WFH or HFA z-scores less than -2. BMI z-score was used for children older than 5 years (<-3 considered severe and <-2 moderate malnutrition). BMI percentile between 85-95% was considered as overweight and BMI percentile >95% classified as obese [9]. Patients were classified using the PNST as either low, medium or high risk and as at risk or not at risk of malnutrition.

Application of the PNST

Overall, the questions included in PNST were similar and covered the same issues as the existing data available. The first question in the PNST (Has child unintentionally lost weight lately?) was considered similar to step 2 of the PYMS [10] and question 4 of the STRONGkids [3]. The second question (Has child had poor weight gain over the last few months?) was similar to question 4 of the STRONGkids. Question 3 (Has child been eating/feeding less in the last few weeks?) was the same as number 3 of the PYMS and STRONGkids, and step 2 of the STAMP tool [11, 12]. The first part of question 4 (Is child obviously underweight/significantly overweight?) was considered equivalent to the first question of STRONGkids while the second part (being overweight) was also assessed according to previous data.

Therefore, each subject that was assessed in the two previous studies utilising the other three screening tools, was reassessed with the consideration of the similarity of the questions included in PNST. As well as assessing the population as a whole, each separate population (Iranian and NZ) was also reassessed separately, to evaluate the results in different populations.

Statistical Analysis

SPSS statistic 23 software (IBM Corporation, New York, USA) was used for statistical analysis. Chi-square was used for comparison of data between groups. Spearman's correlation was used to assess the relationships between anthropometric data and NRS tool results. The inter-rater agreement between pairs of tools were assessed by using Cohen's kappa coefficient test. The significance level was set at <0.05.

RESULTS

The Characteristics of the Patients

The patient group included 281 children altogether, with 119 from Iran and 162 from New Zealand (Table **1**). The children were aged between 12 months and 17.16 years (median 5.3 years).

Table 1: Demographic characteristics of the 281 hospitalised children included in the current analysis. Children were recruited at hospitalization in either Iran or New Zealand (NZ). HFA = height for age, WFA = weight for age

Characteristics	
Country (number, percentage)	
Iran	119 (42.3)
NZ	162 (57.7)
Age (median, range)	
Iranian	5.9 (1-17.16)
NZ	5.1 (1-15.8)
WFA z-score (median)	
Iranian	-0.76
NZ	0.32
HFA z-score (median)	
Iranian	-0.029
NZ	-0.29
Length of stay (Median and range in days)	
Total	2.08 (1.00- 25.63)
Iran	2.16 (1.00-13.00)
NZ	2.00 (1.00-24.63)

Identification of Malnutrition by the Four Tools

The number of malnourished patients was determined for each of the four tools (Table **2**). The PNST was able to recognize 51% of malnourished patients (43% of NZ & 54% of Iranian children), while each of the other three tools was able to recognize more than 85% of the children.

Relationships between z Scores and Score Performance

The sensitivity, specificity, positive and negative predictive values of each tool for various z-scores were assessed (Table **3**). The sensitivity of PNST in recognizing severely malnourished patients based on HFAZ or BMIZ scores, was only 37% compared to 100% for the other three tools. The sensitivity of PNST

Table 2: Comparison between the paediatric NRS tools in regards the recognition of malnutrition. The number of children recognized to be malnourished by the WHO classification (as the gold standard) was evaluated for each of the four nutritional risk screening tools

Malnourished Based on WHO criteria	Recognized by PNST	Recognized by STRONGkids	Recognized by STAMP	Recognized by PYMS
Total 47	24 (51%)	41 (87%)	42 (89%)	40 (85%)
NZ 14	6 (43%)	14 (100%)	9 (64%)	11 (78%)
Iran 33	18 (54%)	27 (82%)	20 (60%)	29 (96%)

Table 3: Sensitivity, Specificity, and Predictive Values for the PNST score cut-offs and the STRONGkids score cut-offs in the identification of malnourished children. Sens = sensitivity, Spec = specificity, PPV = positive predictive value, NPV = negative predictive value, HFA = height for age, WFA = weight for age, BMI – body mass index

Measures	Risk identified by PNST					Risk by STRONGkids				Risk by STAMP				Risk by PYMS			
	No. (%)	Sensitivity	Specificity	PPV	NPV	Sen.	Sp.	PPV	PPV	Sen.	Sp.	PPV	NPV	Sen.	Sp.	PPV	NPV
	75 (27)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(> 2 affirmative Responses) WFAZ																	
≤ -2	32 (11)	50	82	25	95	99	43	17	99	100	60	16	100	89	67	21	98
≤ -3	7 (2)	57	79	5	99	100	62	4	100	100	59	35	100	100	66	47	100
HFAZ																	
≤ -2	16 (6)	37	79	8	96	87	60	12	99	94	59	7	99	68	64	7	98
≤ -3	8 (3)	37	79	4	98	100	70	6	100	100	59	4	100	100	66	5	100
BMIZ																	
≤ -2	28 (10)	46	80	17	94	89	61	20	97	82	60	12	98	96	68	18	99
≤ -3	8 (3)	37	79	4	98	100	70	6	100	100	61	4	100	100	66	5	100

was 37% (HFAZ) and 46% (BMIZ) for moderate malnutrition versus 68-100% for the other 3 tools.

The correlations between WFA, HFA and BMI z-scores and all four tools were determined (Table **4**). None of the tools had a good correlation with the z-scores.

The Agreements between Different NRS Tools

The inter-rater agreement between each pair of tools was assessed and kappa coefficients were compared (Table **5**). The highest agreements were between STRONGkids and STAMP, and between STRONGkids and PYMS, while the PNST tool had the

Table 4: Correlation between the nutrition risk identified by the PNST and the nutrition risk identified by three other tools and nutrition status by z scores. HFA = height for age, WFA = weight for age, BMI – body mass index

Measure	Correlation PNST	Correlation STRONGkids	Correlation STAMP	Correlation PYMS
WFAZ				
≤ -2	-0.17	-0.08	-0.27	-0.30
≤ -3	0.17	0.31	-0.32	
HFAZ				
≤ -2	-0.13	-0.19	-0.65	-0.72
≤ -3	-0.04	-0.57	-0.49	-0.78
BMIZ				
≤ -2	0.09	-0.07	-0.28	-0.13
≤ -3	0.22	0.18	-0.15	

Table 5: Kappa value and inter-rater agreement between the four different tools

	STRONGkids	STAMP	PYMS	PNST
STRONGkids	1	0.57	0.51	0.34
STAMP	0.57	1	0.36	0.2
PYMS	0.51	0.36	1	0.46
PNST	0.34	0.2	0.46	1

lowest agreements with those two tools and a moderate agreement with the PYMS tool.

DISCUSSION

This study has demonstrated that the PNST tool was able to recognize approximately half as many of the malnourished children as the other three tools in this historical data set. In addition, the sensitivity of this tool was also substantially less than that of the other tools (37% versus 68-100%).

An earlier study conducted in Belgium evaluated the STRONGkids tool and demonstrated similar sensitivity (69-71.9%) for this tool [13]. The original study describing the development and validation of the PYMS tool, conducted on 247 paediatric inpatients, also determined high sensitivity for this tool (85%) and compared it with the STAMP tool (81%) [14]. In contrast, a more recent report that included assessment of STRONGkids, PYMS and STAMP in 2567 inpatients in 12 European countries indicated lower utility for these three tools [15]. With regards to the utility of these various tools, Hartman *et al*. [16] has commented that a standardized approach for nutritional screening for paediatric inpatients has not yet been achieved.

The PNST is designed to be simple and rapid, without a requirement for collection of anthropometric measurements. Similarly, the STRONGkids tool does not include collection of weight and height data, whereas STAMP and PYMS do require this data [2-4]. The questions included in the PNST essentially cover the same aspects as included in the previous tools, especially the STRONGkids tool. This allows for reliable retrospective application of the PNST tool in these two cohorts of children. The predominant difference between PNST and STRONGkids is that PNST excludes information about underlying chronic disease. The lack of consideration of the impact of underlying disease could contribute to the differences in the observed sensitivities between these tools and could explain why PNST has lower identification rate of malnutrition.

Due to increasing prevalence of overweight/obesity in children in NZ and many other countries, the consideration of this as a risk factor for malnutrition is advisable. Although the PNST asks about the existence of overweight/obesity, the authors have noted poor sensitivity and specificity in identification of these patients [5]. The current study also showed that there was not a good correlation between z-scores and any of the NRS tools as shown previously [5].

A limitation of this report is that the data was collected retrospectively meaning that the PNST was not applied directly to each patient during their hospitalization but was derived from the previously collected data. This may diminish the accuracy of the conclusions. However, the similarity of the questions included in PNST and the large comprehensive nature of the data set should mitigate against this.

In conclusion, this analysis of previously-collected data illustrates that the PNST has low sensitivity for the recognition of malnutrition in paediatric inpatients when compared to the other three validated NRS tools. Further consideration of the utility of NRS tools in children admitted to hospital is required.

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