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The $STRONG_{kids}$ nutritional screening tool in hospitalized children: A validation study

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ABSTRACT

Objective: The $STRONG_{kids}$ is a nutritional screening tool for hospitalized children, which was found to predict a negative weight for height (WFH) standard deviation score (SDS) and a prolonged hospital length of stay (LOS) in a Dutch population of hospitalized children. This study aimed to test the ease of use and reproducibility of the $STRONG_{kids}$, and to confirm its concurrent and prospective validity in a Belgian population of hospitalized children.
Methods: Reproducibility was tested in a cohort of 29 hospitalized children in a tertiary center and validity was tested in 368 children (105 hospitalized in a tertiary and 263 in three secondary hospitals) ages between 0.08 and 16.95 y (median 2.2 y).
Results: Substantial intrarater ($\kappa = 0.66$) and interrater ($\kappa = 0.61$) reliabilities were found between observations. $STRONG_{kids}$ scores correlated negatively with WFH SDS of the patients ($\rho = -0.23$; $P < 0.01$; odds ratio [OR], 2.47; 95% confidence interval [CI], 1.11–5.49; $P < 0.05$). It had a sensitivity and negative predictive value (NPV) of respectively 71.9% and 94.8% to identify acutely undernourished children. $STRONG_{kids}$ did not correlate with weight loss during hospitalization, but correlated with LOS ($\rho = 0.25$; OR 1.96; 95% CI, 1.25–3.07; both $P < 0.01$) and the set-up of a nutritional intervention during hospitalization (OR, 18.93; 95% CI, 4.48–80.00; $P < 0.01$). The sensitivity and NPV to predict a LOS $\geq$ 4 d were respectively 62.6% and 72%, and respectively 94.6% and 98.9% to predict a nutritional intervention.
Conclusions: $STRONG_{kids}$ is an easy-to-use screening tool. Children classified as "low risk" have a 5% probability of being acutely malnourished, with only a 1% probability of a nutritional intervention during hospitalization.

Introduction

Several studies have suggested that hospitalized children, even with mild clinical conditions, are at risk for development of malnutrition [1–3]. Undernutrition is classically subdivided in acute undernutrition (defined by the World Health Organization [WHO] as weight for height [WFH] <-2 SD) and chronic undernutrition (defined by the WHO as height for age [HFA] <-2 SD) [4,5]. An early determination of children at risk for developing undernutrition might avoid or diminish nutrition-associated complications (slowing of growth and increased susceptibility to various infections) and prolonged hospitalization [6–8]. The main objective of screening is the early detection of a condition at a point when treatment is more effective, less expensive, or both. Decisions for acceptable levels of sensitivity and specificity involve weighing the consequences of leaving cases undetected (false-negatives) against incorrectly

AP, ML, DT, BP, RR, and VY were responsible for the project conception and development of the overall research plan. DSJ and HK were responsible for the study oversight. AP, ML, RR, and BP conducted the research. Data and statistical analyses were performed by HK, DJ, and DSJ. HK, AP, VY, DJ, and DSJ wrote the paper. HK and DSJ had primary responsibility for the final content of the paper. All authors read and approved the final manuscript. DJ received a fee from Nutricia Belgium for his statistical analysis. The other authors have no conflict of interest to report.

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classifying healthy persons as having the condition (false-positives) [9].

Various tools have been developed for nutritional risk screening in hospitalized children [10–12], but a consensus regarding which screening tool to use has not yet been reached. The most recent instrument, the $STRONG_{kids}$, has been developed according to the newest European Society for Parenteral and Enteral Nutrition (ESPEN) guidelines [13] and was shown to correlate well with the current nutritional status and hospital length of stay (LOS) in a Dutch pediatric population and with the risk for later nutritional intervention in a small British group of hospitalized children [12,14]. The questionnaire divides hospitalized children into three risk groups by means of a combination of history of weight loss, clinical impression, and questions regarding nutritional status. However, the reproducibility and applicability by nurses in clinical practice of this instrument has not been investigated.

The aims of our study were to test the ease of use and the reproducibility of the $STRONG_{kids}$ and to confirm both its concurrent and prospective validity in a Belgian population of hospitalized children. In particular, the ability of the $STRONG_{kids}$ to predict the WFH *z* score at admission (concurrent validity), the degree of weight loss during hospitalization, the hospital LOS, and the need for supplementary feeding (prospective validity) in a mixed population (children hospitalized for medical as well as surgical reasons in tertiary and secondary hospitals) was investigated.

Participants and methods

Patient population

For the reproducibility study, 29 children hospitalized at the university hospital (UZ Brussel, Vrije Universiteit Brussel, Brussels, Belgium) were investigated. The median (range) age of the population was 1.5 y (0.4–15.5 y). Respectively two and three children were chronically and acutely malnourished. Five children were suffering from a chronic disease. Retrospectively, none of the children who were scored on 2 different days by the same observer had a change in nutritional intervention on the second screening occasion.

For the validity study, a prospective study was set up in one tertiary (university) hospital (UZ Brussel, Vrije Universiteit Brussel, Brussels, Belgium) and three secondary hospitals (Centre Hospitalier Universitaire Tivoli, La Louvière; Hôpital Civil de Charleroi, Charleroi, Belgium; Jessa Hospital, Hasselt, Belgium). Inclusion criteria were: >1 mo and ≤16 y old, admission to a pediatric or surgical ward, and an expected hospital LOS of at least 1 d. Patients who were admitted to intensive care and patients who were readmitted for the same condition within 7 d postdischarge were excluded. An information letter was provided to all parents and patients who were old enough. Parents or patients could refrain from participation without consequences, which was the case for only two patients. The study protocol was approved by the local ethical committees, which waived the need for a written informed consent.

In each hospital, patients were consecutively enrolled until 100 eligible children were included. Between December 2010 and April 2011, 402 patients were enrolled. The $STRONG_{kids}$ questionnaire was successfully completed by 97.1% of the patients. In all, 368 files were retained for analysis: 23 were excluded because of missing sex or height data, 5 had a preexisting condition that markedly affected hydration (such as severe cardiac insufficiency, ascites, or acute renal insufficiency), and 11 had an incomplete or missing $STRONG_{kids}$ score.

All 368 children included in the analysis had their body weight and height taken on admission, and body weight at discharge was available for 343 children. The total hospital LOS was reported for 342 patients. Baseline patient characteristics are shown in Table 1. On admission, respectively 29 (7.9%) and 32 (8.7%) children were chronically (HFA <-2 SD) and acutely (WFH <-2 SD) malnourished. Forty (11.2%) of the patients were suffering from a chronic disease. Of the 368 children in the study, 228 children were hospitalized for an infectious problem, 34 were admitted for a surgical reason, and 106 for other reasons such as oncologic disease, epileptic insult, syncope, and so on. Of the 343 children with their body weight obtained at discharge, 109 (31.8%) lost weight; of these 41.3% lost >2% of their initial body weight. However, the median (range) absolute and relative weight change was only 0.0 kg (−3.3 to 2.0) and 0.0% (−15.6 to 13.9), respectively. Thirty-seven (10.1%) of the 368 children had a nutritional intervention: 12 (32.4%) received tube feeding, 15 (40.5%), oral supplements, and for 10 (27%) patients the intervention was not well specified.

Table 1
Baseline patient characteristics

	n (%)
Age	
0–1 y	117 (31)
1–2 y	65 (17.2)
2–10 y	129 (34.2)
>10 y	66 (17.5)
Sex	
Male	197 (53.5)
Female	171 (46.5)
WFH <-2 SD	32 (8.7)
HFA <-2 SD	29 (7.9)
Underlying disease	
No	318 (88.8)
Yes	40 (11.2)
Diagnostic category	
Infection	228 (62)
Surgery	34 (9.2)
Other	106 (28.8)
LOS	
<4 d	219 (59.5)
≥4 d	123 (33.4)
Weight loss	
No	234 (63.6)
Yes	109 (31.8)
>2%	45 (13.1)
Nutritional intervention	
No	331 (89.9)
Yes	37 (10.1)

HFA, height for age; LOS, length of stay; WFH, weight for height

$STRONG_{kids}$ nutritional risk score

In the reproducibility study, the $STRONG_{kids}$ questionnaire was completed by two different nurses on the day of admission and the following day to calculate the interrater and intrarater agreements of the questionnaire. In the validation study, the $STRONG_{kids}$ questionnaire (including the questions regarding the subjective clinical assessment and the presence of a high-risk disease) was completed by a nurse (and in one hospital a pediatric resident) on the day of admission or the following day if the child was admitted after 1800 in the three secondary hospitals and by a dietitian in training in the tertiary center. The use of the $STRONG_{kids}$ nutritional score was explained to all investigators in a preceding training session. The duration for completion of the questionnaire was monitored by a stopwatch.

The nutritional risk for each patient was assessed by application of the $STRONG_{kids}$ scoring system (0–5) as previously described [12]: Children with a $STRONG_{kids}$ score of 0 were classified as being at low risk for malnutrition, those with a score between 1 and 3 were at moderate risk, and children with a score ≥4 were considered at high risk for malnutrition. To validate the use of the $STRONG_{kids}$ as a screening tool, we defined a "nutritionally at risk" screening result as children who were scored at moderate or high risk, and a "nutritionally not at risk" screening result as children who were scored at low risk.

Anthropometry

On admission, body length under the age of 2 y, standing height from the age of 2 y and body weight were measured. Body weight also was assessed at discharge. To ensure standardization of measurements, all investigators participated in a training session before the start of the study, and written instructions were provided. The weight and height measurements were acquired using the standard procedure as described in 1966 [15]. Children were weighed wearing minimum clothing (in the case of infants without a diaper) and with bare feet using a calibrated digital weighing scale, the result was recorded to the nearest 10 g.

Body weight, HFA, and WFH data were compared with the reference population described previously [16] and translated into *z* scores. WFH <-2 SD and HFA <-2 SD were used to define acute and chronic malnutrition, respectively.

Clinical data output

Age, sex, the clinical diagnosis at discharge, and hospital LOS were recorded. Admissions were categorized as infectious, surgical, and others. Information

about any underlying disease was gathered on admission. Children were categorized in four age groups: infants (<1 y), toddlers (1–2 y), young children (2–10 y), and older children (>10 y). Based on duration of hospitalization, children also were divided in two groups: those with an LOS equal to or greater than the median duration, and those with an LOS less than the median. To allow comparison with data from a previous study [17], we calculated the absolute (kg) and relative (%) weight change, to identify those children who lost ≤2% and >2% of their body weight. Relative weight change was calculated using the following formula:

$$\%\ \text{weight change} = \frac{\text{weight change (Kg)}}{\text{weight change (Kg)} + \text{discharge weight (Kg)}} \times 100\%$$

Statistical analysis

HFA, LOS, relative and absolute weight change, and time for $STRONG_{kids}$ completion were distributed asymmetrically. Cohen's κ was calculated to determine intrarater and interrater agreement. Spearman's ρ was used to determine correlations between continuous variables. A χ^2 test was performed to compare proportions between groups. The means and medians of continuous variables were compared using a Student's *t* test and a Mann-Whitney U test, respectively. Logistic regression analysis was used to calculate odds ratio's to compare "nutritionally at risk" versus "nutritionally not at risk" children. Sensitivity, specificity, the negative predictive value (NPV) and the positive predictive value (PPV) values were calculated for the following outcome variables: WFH <-2 SD, HFA <-2 SD, hospital LOS <4 d, weight loss >2% and the start of a nutritional intervention during hospital stay. A *P*-value < 0.05 was considered significant. The SPSS v 19.0 (SPSS Inc, Chicago Ill., USA) software was used.

Results

Reproducibility

On the same day, 15 (36.6%), 6 (14.6%), 9 (22%), 3 (7.3%), 6 (14.6%), and 2 (4.9%) children were given a total amount of respectively 0 of 5 through 5 of 5 points by a first observer and respectively 12 (29.3%), 7 (17.1%), 8 (19.5%), 9 (22%), 4 (9.8%), and 1 (2.4%) children by a second observer. Consequently, 15 (36.6%), 18 (43.9%), and 8 (19.5%) children were deemed at respectively low, moderate, and high nutritional risk by a first observer, and respectively 12 (29.3%), 24 (58.5%), and 5 (12.2%) children by a second observer. Of the children who were scored on 2 separate days by a same observer, 4 (16%), 6 (24%), 7 (28%), 5 (20%), and 3 (12%) were given a total amount of respectively 0 of 5 through 5 of 5 points on the first occasion and respectively 4 (16%), 6 (24%), 5 (20%), 6 (24%), 3 (12%), and 1 (4%) on the second occasion. Accordingly, 4 (16%), 18 (72%), and 3 (12%) children were deemed at low, moderate, and high nutritional risk on the first occasion; whereas on the second occasion this was the case for respectively 4 (16%), 17 (68%), and 4 (16%) children.

Using a previously developed grading system [18], the total sum of risk points showed a moderate interrater and intrarater agreement: κ values were respectively 0.48 and 0.60 (both $P < 0.01$). For the $STRONG_{kids}$ risk score, there was a substantial interrater and intrarater agreement (respectively κ values of 0.61 and 0.66; $P < 0.01$).

Time spending

The median time spending for completing the $STRONG_{kids}$ in the whole population of 250 in whom the timing was logged was 3 min. In only one patient (0.4%) the questionnaire took more than 5 min to be assessed.

Validation

Of our validation population, 174 children (47.3%) had a total of 0 of 5 risk points; 97 (26.4%) had 1 of 5; 46 (12.5%) 2 of 5 questions; 23 (6.3%) 3 of 5; and 14 (3.8%) had 4 of 5 and 5 of 5 points. The questionnaire divided the children into three significantly ($P < 0.01$) different risk groups: 174 children (47.3%) were scored at low risk, 166 (45.1%) at moderate risk, and 28 (7.6%) children were considered to be at high nutritional risk. In other words, 47.3% of the children had a "nutritionally not at risk" screening result, whereas 52.7% had a "nutritionally at risk" screening result.

An overview of the $STRONG_{kids}$ risk scores is displayed in Table 2. Distribution of age and diagnostic categories were significantly (respectively $P < 0.05$ and $P < 0.01$) different among the different risk groups. The median [range] age of children in the high-risk group (6.24 y [0.1–16.3]) was significantly ($P < 0.01$) higher than that of children in the moderate (1.77 y [0.1–17.0]) and low (2.13 y [0.1–17.0]) risk groups, whereas there was no significant ($P = 0.26$) difference between the low and moderate (1.77 y [0.1–17.0]) risk group. However, there was no significant correlation between age and risk category ($\rho = 0.04$; $P = 0.46$). The percentage of children suffering from an underlying disease increased significantly ($P < 0.01$) with each nutritional risk level: 6% in the low-risk group, 9.4% in moderate-risk group and 88.9% in high-risk group.

Concurrent validity

Results of concurrent validity are presented in Table 3. WFH *z* score is significantly ($P < 0.01$) negatively correlated with $STRONG_{kids}$ risk categories ($\rho = -0.23$). The mean WFH *z* score in the low-risk group was 0.06 (95% CI, −0.13 to 0.25, which is significantly $P < 0.01$) higher than that of the moderate- and high-risk groups (respectively −0.35 [95% CI, −0.55 to −0.14] and −1.13 [95% CI, −1.63 to −0.63]). The mean WFH *z* scores of the moderate-risk group were also significantly ($P < 0.01$) higher than those of the high-risk group. Eight (25%) of the acutely malnourished children were classified in the high-risk category, 15 (46.9%) in the moderate-risk, and 9 (28.1%) in the low-risk category. The odds of "nutritionally at risk" versus "nutritionally not at risk" for acutely undernourished children was 2.47 (95% CI, 1.11–5.49) times greater compared with children with a WFH ≥2 SD ($P < 0.05$). The $STRONG_{kids}$ had a sensitivity of 71.9%, a specificity of 49.1%, an NPV of 94.8% and a PPV of 11.9% for detecting acutely malnourished children.

No correlation between HFA *z* scores and $STRONG_{kids}$ risk categories was present ($\rho = -0.06$; $P = 0.24$). The median [range] HFA *z* score in the low-risk group (−0.17 [−3.69 to 2.72]) was not significantly ($P = 0.45$) different from the median HFA *z* scores in the moderate-risk group (−0.13 [−6.11 to 3.49]), but was, however, significantly ($P < 0.01$) different from the median HFA

Table 2
Overview of $STRONG_{kids}$ nutritional risk classification

	Low risk n (%)	Moderate risk n (%)	High risk n (%)	*P*-value
General	174 (47.3)	166 (45.1)	28 (7.6)	<0.01
Age				<0.05
0–1 y	55 (32.0)	54 (32.5)	3 (10.7)	
1–2 y	28 (15.1)	34 (20.5)	4 (14.3)	
2–10 y	58 (33.7)	57 (34.3)	11 (39.3)	
>10 y	33 (19.2)	21 (12.7)	10 (35.7)	
Underlying disease				<0.01
No	171 (99.4)	144 (90.6)	3 (11.1)	
Yes	1 (6)	15 (9.4)	24 (88.9)	
Diagnostic category				<0.01
Infection	88 (50.6)	129 (77.7)	11 (39.3)	
Surgery	23 (13.2)	10 (6)	1 (3.6)	
Other	63 (36.2)	27 (16.3)	16 (57.1)	

Table 3
Concurrent and prospective validity of the $STRONG_{kids}$

	Correlation (ρ=)	Sens‡ (%)	Spec‡ (%)	NPV‡ (%)	PPV‡ (%)	OR (95% CI) ‡
Concurrent validity						
WFH	−0.23*	71.9	49.1	94.8	11.9	2.47 (1.11–5.49)†
HFA	−0.06	69.0	48.4	94.8	10.4	2.12 (0.94–4.79)
Prospective validity						
LoS	0.25*	62.6	53.9	72.0	43.3	1.96 (1.25–3.07)*
W loss	0.01	52.6	43.1	29.7	66.5	0.84 (0.53–1.33)
Ntr int	0.48*,§	94.6	52.0	98.9	18.0	18.93 (4.48–80.00)*

CI, confidence interval; LOS, length of stay; NPV, negative predictive value; ntr int, nutritional intervention; OR, odds ratio; PPV, positive predictive value; sens, sensitivity; spec, specificity; w loss, weight loss
* significant at level $P < 0.01$.
† significant at level $P < 0.05$.
‡ moderate- and high-risk grouped together.
§ Cramer's V instead of ρ.

z score of the high-risk group (−1.13 [−5.37 to 1.29]). The difference between the median HFA *z* scores in the moderate- and high-risk groups was also significant ($P < 0.01$). According to the $STRONG_{kids}$ 6 (20.7%) of the children suffering from chronic undernutrition were at high nutritional risk, 14 (48.3%) at moderate risk, and 9 (31%) were at low nutritional risk. The odds ratio for nutritionally at risk versus nutritionally not at risk for chronically undernourished children was 2.12 (95% CI, 0.94–4.79) compared with children with an HFA > -2 SD, however, this was not significant ($P = 0.07$). The $STRONG_{kids}$ had a sensitivity of 69%, a specificity of 48.4%, an NPV of 94.8%, and a PPV of 10.4% for detecting chronically malnourished children.

Prospective validity

Results of prospective validity are presented in Table 3. The median (range) LOS for children in the low-risk group was 4 d (1–34 d), 4 d (1–64 d) in the moderate-risk group, and 6 d (2–27 d) in the high-risk group. The medians of the LOS in all the risk groups were significantly ($P < 0.01$) different from each other. There was a significant ($P < 0.01$) positive correlation between hospital LOS and $STRONG_{kids}$ risk category ($\rho = 0.25$). The odds ratio for nutritionally at risk versus nutritionally not at risk for children who were hospitalized ≥ 4 d was 1.96 (95% CI, 1.25–3.07) times greater compared with children with a hospital LOS of <4 d ($P < 0.01$). The $STRONG_{kids}$ had a sensitivity of 62.6%, a specificity of 53.9%, an NPV of 72% and a PPV of 43.3% for detecting children who are at risk for longer hospitalization than the median.

$STRONG_{kids}$ risk category did not correlate significantly with absolute or relative weight change (data not shown). Additionally, the median relative weight change in the low-risk category was not significantly different from that of the moderate-risk ($P = 0.25$) or high-risk ($P = 0.19$) groups (data not shown). Of the children who had their body weight recorded on discharge, 64 (18.7%) lost weight during hospitalization, with 45 (70.3%) of these children losing >2% of their body weight. Eight (17.8%) children who lost >2% of their body weight were classified as being at high risk, 21 (46.7%) were at moderate risk, and 16 (35.6%) were at low risk. Of the 8 who lost >5% of their body weight, 3 were deemed at low nutritional risk, 4 at moderate risk, and only 1 at high nutritional risk by the $STRONG_{kids}$ classification. The odds for nutritionally at risk versus nutritionally not at risk for children losing >2% of their body weight was 0.84 (95% CI, 0.53–1.33) times greater compared with children losing > 2%, however, this was not significant ($P = 0.46$). The $STRONG_{kids}$ had a sensitivity of 52.6%, a specificity of 43.1%, an NPV of 29.7%, and a PPV of 66.5% for detecting children who lose >2% of their initial body weight during hospitalization.

For 37 (10.1%) children, a nutritional intervention was started during their hospital stay. Only 2 (5.4%) of these children were classified as low risk, whereas 19 (51.4%) were classified as moderate risk, and 16 (43.2%) as high risk. The odds ratio for nutritionally at risk versus nutritionally not at risk for children who received a nutritional intervention was 18.93 (95% CI, 4.48–80.00) compared with children who did not ($P < 0.01$). The $STRONG_{kids}$ has a sensitivity of 94.6%, a specificity of 52%, an NPV of 98.9%, and a PPV of 18% for detecting chronically malnourished children.

Discussion

This study is the first to validate the $STRONG_{kids}$ nutritional screening tool on all ESPEN guideline items in a large pediatric study population in a developed country. The results indicate that the $STRONG_{kids}$ is an easy-to-use and rapid screening tool with a median completion time of only 3 min and a substantial intrarater and interrater reliability. This study is also the first to validate the use of the $STRONG_{kids}$ by nurses. We found a good correlation with the current nutritional status (WFH *z* score), but not with HFA *z* score. As parameters of prospective validity, hospital LOS, and nutritional interventions during hospitalization were found to be predicted by the $STRONG_{kids}$.

Most other reports on pediatric screening tools have mainly concentrated on the questionnaires' diagnostic rather than screening capabilities by focusing on the discriminative power of the high-risk category versus the low-risk category, or the high-risk versus the moderate- and low-risk categories combined [11,12,19–22]. However, testing should only be performed in clinical practice if its result is likely to change the nutritional approach to the patient. In this case, following the nutritional care algorithm published by the American Society for Parenteral and Enteral Nutrition [23], the objective is to rule out that children who are exempted from full nutritional assessment after being screened as nutritionally not at risk are in fact at risk for developing malnutrition or already malnourished. This implies that the specificity is less important in screening for undernutrition because a false-positive result will only expose the patient to a full dietetic assessment, whereas a false-negative result may lead to unrecognized undernutrition.

This study indicates a significant relationship of the $STRONG_{kids}$ with current nutritional status. This is in accordance with the findings of the original publication of the $STRONG_{kids}$ in a Dutch population and those of another study that tested the

use of the $STRONG_{kids}$ in a developing country [12,22]. In a small population of 43 British children, the first study reported a high correlation between $STRONG_{kids}$ risk categories and WFH *z* scores. Our large Belgian study population had a prevalence of 8.7% acute malnutrition at admission, which is consistent with results of other studies in developed countries [2,6,8,24]. Therefore, the NPV and PPV of respectively 94.8% and 11.9% can be considered as representative for other developed countries as well. In practice, this means that in a population with a prevalence of 8.7% acute malnutrition, children classified as low risk by the $STRONG_{kids}$ will have a 5% probability of being acutely malnourished, but only a 1% probability of a nutritional intervention during hospitalization. In contrast to the findings of the three other studies that reported on the $STRONG_{kids}$, we did not find a correlation between $STRONG_{kids}$ risk categories and HFA *z* scores [12,14,22]. A possible explanation is that the median age of our study population (2.2 y) is lower than in the other studies (varying from 3.5 y to 6.3 y) and that the nutritional effects of the underlying disease increase with the duration of the underlying disease. Furthermore, in Westernized countries, genetic factors as well as intrauterine growth retardation are probably a more significant element in the cause of short stature than poor nutritional state. This study is the first to test the odds ratio, sensitivity, and NPV of a nutrition screening tool for its capability to detect acute or chronic undernutrition in children. Others mainly have focused on comparison with other tools [11], or have used a full dietetic assessment as a reference [11,20,21]. In our opinion, the use of internationally accepted criteria for undernutrition as a reference to assess concurrent validity leaves less room for bias, but a single weight measurement at diagnosis or discharge might not be the best parameter to validate a nutrition screening tool. This is why we also assessed the prospective validity of the $STRONG_{kids}$ in regard of its relationship with the setup of a nutritional intervention and hospital LOS.

Our results also confirmed the relationship of the $STRONG_{kids}$ with hospital LOS. This finding was previously reported on [12], but also in an Iranian study of 119 children that described that the median hospital LOS for children in the high-risk category compared with those in the low-risk category was more than 200% longer [22]. On the other hand, we did not find a significant correlation between $STRONG_{kids}$ risk categories and weight loss during hospitalization. This result was to be expected because the weight changes during hospitalization were very minimal in our population. So far, the only screening tool that has been reported to predict weight loss during hospitalization is the Pediatric Nutritional Risk Score [17]. This particular instrument, however, was mainly based on factors that showed to be most predictive of in-hospital weight loss in the study population, such as poor food intake, pain, and severity of disease [17].

The $STRONG_{kids}$ was most strongly correlated with the setup of a nutritional intervention during hospital stay. A negative screening score excluded nearly all children with a nutritional intervention during hospital stay in our study population. A comparative study also found that $STRONG_{kids}$, as well as the Screening Tool for the Assessment of Malnutrition in Paediatrics, detected all the children with a nutritional intervention as being at high risk [14].

The fact that the $STRONG_{kids}$ questionnaire is user-friendly is illustrated in the 97.1% completion rate. This is equally high as reported in a previous study [12], and much higher than the 72.3% reported in a validation study of the Paediatric Yorkhill Malnutrition Score [11]. Our study is the first to report on the actual time spending for completion of the screening tool (median duration of 3 min), which allows for implementation in everyday practice. We found a substantial interrater agreement, which has not yet been tested. These findings illustrate that busy nurses in everyday practice can use the $STRONG_{kids}$ nutritional screening tool reliably in everyday practice.

Our study also has some weaknesses. First, because this was a multicentric study, anthropometric measurements were done by different investigators. Results might thus be influenced by interobserver variability. However, we feel that we were able to minimize this because all investigators participated in a training session before the start of the study and they received written instructions. Second, we did not assess the extra workload that this screening process would put on the hospital dietitian. The $STRONG_{kids}$ showed good results regarding sensitivity and NPV, but with 52.7% of the population with a positive screening result, and the rather poor specificity and PPV of the screening tool it is not unthinkable that the $STRONG_{kids}$ will pose an extra burden on dietitians with unnecessary referrals.

In conclusion, this study authenticates the $STRONG_{kids}$ as a nutritional screening tool for hospitalized children. It is rapid and easy to use for nurses in everyday practice. Children classified as low risk have a 5% probability of being acutely malnourished, with only 1% probability of a nutritional intervention during hospitalization.

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