Prevalence of malnutrition risk and acute malnutrition in pediatric population in a tertiary hospital and their burden on healthcare

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Abstract

**Background:** Malnutrition is related to an increased rate of complications and prolonged hospital stays. Malnutrition risk screening is recommended for all hospital inpatients, but its applicability as part of routine care is not well known.

**Methods:** The prevalence of malnutrition risk, measured by the Screening Tool for Risk of Impaired Nutritional Status and Growth (STRONGkids), and acute malnutrition were studied 1 day per year in all pediatric inpatient and day wards in 2015 and 2016 and in inpatients and outpatients in 2017 at a university hospital. Nurses carried out the STRONGkids screening and measured the weight and height of each child, recording the information in the hospital database, where it was subsequently extracted along with data on the child's diagnoses, procedures, and the length and costs of hospital stay.

**Results:** In all, 696/1217 patients (57.2%) were screened. Of inpatients and outpatients, 37/398 (9.3%) and 3/298 (1.0%), respectively, were classified as being at high risk of malnutrition. The corresponding figures for those who were acutely malnourished were 18/260 (6.9%) and 11/264 (4.2%). High risk of malnutrition increased the costs and length of hospital stay ($P < .05$). Dietetic input was involved during hospital stay in 12/37 (32.4%), 32/173 (18.5%), and 13/188 (6.9%) of inpatients at high, moderate, and low risk, respectively ($P < .001$). Nutrition risk screening did not detect all patients classified as acutely malnourished.

**Conclusion:** Hospitals need to ensure proper application of nutrition screening, develop a protocol for the care of children at nutrition risk, and monitor the use of this protocol.

**Keywords**

child, infant, malnutrition, nutrition assessment, nutrition screening, pediatrics
INTRODUCTION

Malnutrition leads to increased complications and longer hospital stays and diminishes quality of life. European and national guidelines recommend malnutrition risk screening for all hospital inpatients. Early nutrition risk screening aims to prevent malnutrition through early intervention when problems are encountered.

The Screening Tool for Risk of Impaired Nutritional Status and Growth (STRONGkids) is a validated screening method to detect risk of malnutrition. It evaluates the following items: subjective clinical assessment, high-risk disease, nutrition intake, and weight loss. The tool classifies children as being at low, moderate, or high risk for malnutrition. The STRONGkids method was chosen as the screening tool for use at our hospital, as reported in our recently published study. Concerns have been raised regarding the use of malnutrition risk screening tools in recent years. In several publications, the screening method has been shown to work within research settings; however, its functionality has not been studied when applied to a real-life situation with nurses.

Our aims were to study the prevalence of malnutrition risk and acute malnutrition in our university hospital pediatric wards and outpatient clinics in a larger population, to study the association between the STRONGkids classification and acute malnutrition when implemented by nurses, and to evaluate the association of malnutrition and malnutrition risk with hospital length of stay (LOS) and its associated costs.

METHODS

Malnutrition risk scores, measured by the STRONGkids screening tool, and the prevalence of acute malnutrition were studied in all pediatric wards in a hospital district for 1 day per year for 3 consecutive years (2015, 2016, and 2017). The tertiary hospital has approximately 200 beds in pediatric general, surgical, and neurological wards. The pediatric specialties comprised allergology, endocrinology, gastroenterology, hematology, cardiology, infectious diseases, nephrology, otorhinolaryngology, and general pediatrics. In 2017, we expanded the screening to include ambulatory visits. Children in pediatric or neonatal intensive care units, infants <1 month of age, and children >18 years of age were excluded from the study. Nurses conducted the malnutrition risk screening according to Hulst et al. Nurses also measured the children’s standing height with a stadiometer or recumbent length with an infantometer and weight with a calibrated digital scale or baby scale, as appropriate for the child’s age. Measurements were taken of children in minimal clothing or nude. The nurses recorded the information on malnutrition risk as well as height and weight in an electronic hospital database as part of their routine care. Nurses were trained to screen for malnutrition risk initially in a weekly staff meeting, in which a registered dietitian presented the steps for malnutrition risk screening and subsequently assisted with queries within each ward. After the initial implementation of the STRONGkids screening method, an annual lecture, also available online, was held for the hospital staff. A dietitian was available to answer any questions. Hospital policy ensures nurses screen all inpatients for malnutrition risk as a part of their routine care. Patient information was recorded regarding height, weight, diagnoses, procedures, LOS, hospital costs, and any dietetic consultations made during their hospitalization and was subsequently retrieved from the hospital database. Hospital costs include all of the associated fees: hospital stay, ambulatory visit, laboratory and other investigations, medications, and procedures and rehabilitation carried out during the hospital stay or, in the case of ambulatory visit, during the same day of the visit. If height and weight measurements were not available on the study day, measurements taken within 2 weeks were accepted. The study used national growth charts to draw weight-to-height percentages. The researcher pulled the weight-to-height percentage for each child from their growth charts. Acute malnutrition was defined according to national guidelines by weight-to-height ratio (< −15% for heights under 130 cm, < −20% for heights between 130 and 160 cm, and < −25% for heights over 160 cm), which is equivalent to the international classification of diseases, ICD-10 defining acute malnutrition as weight-to-height standard deviation (SD) < −2.

The sample size was calculated at 138 to detect high risk of malnutrition, with a 95% CI and a 5% margin of error. Data handling and statistical analysis were carried out with IBM SPSS Statistics version 24. Fisher exact tests and $\chi^2$ tests were used for differences between categories, and Mann-Whitney U test or Kruskal-Wallis test was used for differences in costs and LOS by malnutrition or risk scores. Sensitivity, specificity, and negative and positive predictive values were calculated. The study protocol was approved by the Ethics Committee of Helsinki University Hospital.

RESULTS

Patients

In total, 696 (57.2% of the 1217 children aged from 1 month to 18 years cared for during the study days) pediatric patients were screened. Inpatient numbers totaled 162 in
Malnutrition risk

Malnutrition risk was screened in a total of 398 inpatients and 298 outpatients. Of inpatients, 37/398 (9.3%) and, of outpatients, 3/298 (1.0%) were classified as being at high risk of malnutrition according to STRONGkids (Table 2). No significant difference in malnutrition risk emerged between the study years \((P = .894)\); however, more inpatients than outpatients had high risk scores \((P < .001, \text{Table 2})\). The specialty with the highest number of patients with high malnutrition risk was among hematologic patients (11/34, 32.4%).

**Acute malnutrition**

Acute malnutrition could be determined for those children whose height and weight were measured, in 260/398 (65.3%) inpatients and 264/298 (88.6%) outpatients. Acute malnutrition was seen in 18/260 (6.9%) of the inpatients and 11/264 (4.2%) of the outpatients according to the national classification (Table 2).

**Associations between malnutrition risk, acute malnutrition, and other factors**

Of the acutely malnourished children, the malnutrition risk was low in 11/29 (37.9%), moderate in 12/29 (41.4%), and high in 6/29 (20.7%) children. For the acutely malnourished children to be categorized as high risk, sensitivity was 20.7%, specificity 95.4%, positive predictive value 20.7%, and negative predictive value 95.4%.

The median LOS was longer \((P = .001)\) and costs were higher \((P < .001)\) for patients at high risk than for patients at low risk, but the difference in costs and LOS did not reach statistical significance between the acutely malnourished and the not acutely malnourished (Table 3). Need of intensive care during hospitalization was highest among high-risk patients \((P < .001, \text{Table 3})\). High-risk patients also had the highest occurrence of dietic input during their hospital stay \((P < .001, \text{Table 3})\). The age of the child was not associated with STRONGkids score or acute malnutrition (data not shown).

**DISCUSSION**

Of the screened pediatric population in our hospital district’s tertiary care, approximately 1 in 10 inpatients were at high risk of malnutrition, whereas high risk was seen in only 1 in 100 outpatients. The prevalence of acute malnutrition was 6.9% in inpatients, which is comparable to the results of a large European multicenter study.\(^3\) Even

### Table 1: Characteristics of the screened patients \((n = 696)\)

| Characteristic | N = 696 |
|---------------|---------|
| Age (years), median (IQR) | 6.7 (2.2–13.0) |
| Sex, n (%)      |         |
| Male           | 366 (52.6) |
| Female         | 330 (47.4) |
| Height z-score, mean (±SD) | 0.63 (±1.8) |
| Weight-to-height percentage, mean (±SD) | 1 (±19.7) |
| Specialty, n (%) |       |
| Pediatric      | 379 (54.5) |
| Surgical       | 140 (20.1) |
| Neurologic     | 77 (11.1)  |
| Psychiatric    | 54 (7.7)   |
| Not defined    | 46 (6.6)   |

Abbreviations: IQR, interquartile range.

### Table 2: Prevalence of malnutrition risk and acute malnutrition in pediatric hospital inpatients and outpatients in a tertiary hospital \((n = 696)\)

| Malnutrition risk\(^*\) | Inpatients, n (%) | Outpatients, n (%) | Total, n (%) |
|--------------------------|-------------------|--------------------|--------------|
| Low                      | 188 (47.2)        | 239 (80.2)         | 427 (61.4)   |
| Moderate                 | 173 (43.5)        | 56 (18.8)          | 229 (32.9)   |
| High                     | 37 (9.3)          | 3 (1.0)            | 40 (5.7)     |
| Acute malnutrition\(^*\) |                   |                    |              |
| No                       | 242 (93.1)        | 253 (95.8)         | 495 (94.5)   |
| Yes                      | 18 (6.9)          | 11 (4.2)           | 29 (5.5)     |

\(^*\)P < .001 for difference between inpatients and outpatients.

\(^*\)Malnutrition could be determined only for those patients who had both height and weight measurements available. Acute malnutrition was defined according to national guidelines as weight-to-height < −15% for heights under 130 cm, < −20% for heights between 130 and 160 cm, and < −25% for heights over 160 cm.
with the current obesity epidemic, malnutrition remains an issue in chronically ill children.\textsuperscript{12,13} The low number of dietetic consultations for malnourished children is alarming.

The main strength of this study lies in the relatively large and representative population evaluated. We were able to include all pediatric, surgical, and neurological wards as well as ambulatory units in all the hospitals, both local and university, in a hospital district, making this a representative sample of tertiary care patients. However, information entered by nurses was derived from the hospital database, introducing a risk of bias. The structured hospital database does not include information on premature babies’ gestational age, and therefore, we could not determine chronic malnutrition reliably. Another limitation is that not all children were screened on the day of arrival, nor did they all have their weight and height measured and recorded in the hospital database within the set time limit. The database also does not include information on the children’s hydration status; thus, fluid overloading could not be taken into account. The relatively low screening rate renders some uncertainty to the true prevalence of malnutrition and malnutrition risk. However, it is also possible that there are inaccuracies in the number of patients enrolled in the wards on specific dates. The screening was conducted during the nurses’ morning shift, and children who were discharged in the morning and those who were outside the ward for investigations, procedures, or home visits were likely not screened, which may also bias the results. There is also a potential bias toward healthier children because very ill children may be more difficult to measure.

The link between malnutrition or malnutrition risk and LOS has been shown in several studies in pediatric populations.\textsuperscript{1,7,14–17} In our study, patients screened as being at high risk of malnutrition spent 4 times as long in the hospital as patients screened as being at low risk of malnutrition. However, in contrast to a larger study,\textsuperscript{1} we did not detect a difference in LOS between acutely malnourished and not acutely malnourished children. The smaller population in our study may have prevented detection of an association between nutrition status and LOS. Differences in discharge practices may also have an impact.

The STRONGkids tool has been reported to work well when applied by nurses, as compared with pediatricians.\textsuperscript{18} Contrary to our previous publication, in which the study was conducted by a nutrition researcher and the sensitivity of the screening for acute malnutrition was 100%,\textsuperscript{6} the present study, which depicts a real-life situation in which nurses carry out the nutrition risk screening as part of routine care, shows much lower sensitivity values. Since, in practice, nurses carry out nutrition risk screening because of a lack of dietetic resources, there is a need for continuing

### TABLE 3

| Low risk | Median(IQR) hospital LOS and costs per patient in inpatients (n = 398) according to malnutrition risk and acute malnutrition in a tertiary hospital |
|----------|----------------------------------------------------------------------------------------------------------------------------------|
|          | LOS days, median(IQR) | Costs (€), median(IQR) |
| Low risk | n = 388 | 2 (1–7) | 4470 (1790–11,780) |
| Moderate risk | n = 173 | 4 (1.5–11) | 5320 (2130–14,030) |
| High risk | n = 37 | 8.5 (2.25–20.25) | 6240 (2710–23,700) |

Costs (€), median(IQR) |

| Low risk | n = 388 | 5850 (2640–84,190) |
| Moderate risk | n = 173 | 6970 (3030–23,400) |
| High risk | n = 37 | 9410 (3310–16,260) |

### Abbreviations:

- IQR, interquartile range
- LOS, length of stay

**Statistical significance:** determined with Kruskal-Wallis test, Mann-Whitney U test, or Fisher exact test as appropriate.

Malnutrition could be determined only in those patients who had both height and weight measurements available.
their education and enhancing their motivation for the screening. Assuring interrater reliability by double-checking the malnutrition risk screening with 2 different nurses would ascertain the proper application of the tool. In addition, nurses’ basic education should emphasize the importance of nutrition and its impact on patients’ recovery. The lack of hands-on training of nurses also coincides with the decline in the number of screened patients from 2015 to 2016 and 2017. In the future, we need to address the reasons behind the decline in screening and develop strategies to improve the daily screening rate.

However, even though sensitivity and specificity were low, this does not necessarily mean that the tool was used incorrectly; the World Health Organization (WHO) criteria for malnutrition are crude, not taking into account other factors affecting weight such as fluid balance. Nutrition risk is not equivalent to weight-to-height SD but is much more complex, making weight-to-height a suboptimal, albeit often used, reference for malnutrition screening. In this study, we used national growth charts to identify acute malnutrition. Unfortunately, a more detailed evaluation of nutrition status could not be completed in this setting.

Screening is of no use if it does not lead to better care. In this study, more children who were screened as high risk were referred to a dietitian, as compared with those who were screened as low risk, which is in accordance with previous studies assessing nutrition risk and nutrition intervention or support. However, two-thirds of the patients screened as being at high risk of malnutrition were not referred to a dietitian during their hospitalization, although the hospital guidelines indicate a dietetic care plan for every patient screened as high risk. This may be due to a lack of dietetic resources as well as inadequate familiarization of nursing staff with the guidelines. Attitudes toward dietetic treatment of children may also play a role.

Contrary to the guidelines, the height and weight of all children were not measured, partly because of a lack of special equipment or a lack of equipment in isolation rooms. The possibility of measuring the children needs to be ensured along with motivating the nurses to check and record the children’s measurements as instructed.

In conclusion, acute malnutrition and high risk of malnutrition were detected in a high number of patients. This emphasizes the necessity of an effective screening procedure as a part of routine medical treatment. Furthermore, since only a small proportion of the detected malnourished children were referred to a dietitian, hospitals should design protocols that ensure the dietetic care of at-risk children and monitor their implementation.

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AUTHOR CONTRIBUTIONS
Jetta Tuokkola, Helena Orell, Anniina Heikkilä, and Kristiina Junttila equally contributed to the conception and design of the research; Jetta Tuokkola, Anniina Heikkilä, and Helena Orell contributed to the acquisition of the data; Jetta Tuokkola contributed to the analysis of the data; Jetta Tuokkola and Helena Orell contributed to the interpretation of the data; and Jetta Tuokkola drafted the manuscript. All authors critically revised the manuscript, agreed to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

CONFLICT OF INTEREST
None declared.

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