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Investigating preoperative nutritional status and determining the predictors of nutritional status in pediatric surgery patients

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ABSTRACT

Objective: This study aimed to evaluate the preoperative nutritional status of pediatric surgery patients and identify predictive factors influencing malnutrition.

Methods: A descriptive, cross-sectional study was conducted at a tertiary university hospital. Data were collected through structured interviews with mothers of children aged three months to 16 years scheduled for elective surgery. Nutritional status was evaluated using STRONGkids tool, Gomez, Waterlow, and WHO classification. Logistic regression identified nutritional risk predictors.

Results: Among 162 participants, Gomez and Waterlow classifications show that 66.0% and 76.5% of children are normal, respectively, while WHO classification (z-scores) show that 50.0% of children are in the normal range, while 4.9% are severely undernutrition when calculated without distinction of age. It also shows that 52.5% of children under 5 years of age are normal, 4.9% are severely undernutrition according to WHO classification, and 50.0% of children over 5 years of age are normal, 4.2% are severely undernutrition. Significant differences in nutritional risk were observed based on gender ($p=0.03$), chronic disease presence ($p<0.01$), and type of surgery ($p<0.01$). The analysis revealed that children undergoing thoracic surgery had a 3.16-fold higher nutritional risk compared to those undergoing abdominal or genitourinary surgeries. The length of hospital stays increased nutritional risk by 1.11 times per day. Maternal feeding attitudes were significantly associated with nutritional risk ($p<0.01$). Preoperative laboratory values indicated lower hemoglobin, hematocrit, and albumin levels in high-risk groups.

Conclusions: Preoperative nutritional assessment is crucial in pediatric surgery. Surgery type, hospitalization length, and maternal attitudes significantly impact nutritional risk. Early identification and targeted interventions can improve postoperative outcomes and reduce complications. Further research should explore the effects of age and chronic disease on nutrition.

Keywords: pediatric surgery, nutritional status, STRONGkids tool, Gomez classification, Waterlow classification, z score, predictive factors

Introduction

Preoperative nutritional status plays a crucial role in pediatric surgery, significantly impacting surgical outcomes, recovery time, and overall health.[1] Malnutrition before surgery is associated with increased postoperative complications, prolonged hospital stays, and delayed wound healing.[2,3] Research indicates that 45% to 62% of hospitalized children experience malnutrition, with longer hospital stays exacerbating the nutritional decline.[4,5] Thoracic surgeries pose the highest risk due to their effects on respiratory function and metabolism,

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highlighting the need for thorough nutritional assessment and intervention.[6]

Several factors contribute to preoperative malnutrition in pediatric surgery patients. Surgical stress, metabolic demands, chronic conditions, and extended hospitalization increase the risk of nutritional deterioration.[6] Maternal feeding attitudes and parental stress significantly affect children's preoperative nutrition.[7] Studies show that negative feeding behaviors and heightened parental anxiety correlate with child malnutrition[8], whereas educational interventions for parents can improve children's nutritional status and overall well-being.[9]

Despite the known effects of malnutrition on surgical outcomes, research on preoperative nutritional risk remains limited. Most existing studies focus on specific surgical subgroups rather than comprehensively analyzing pediatric surgery patients.[10,11] To address this gap, this study evaluates preoperative nutritional status using validated assessment tools such as the STRONGkids Nutrition Screening Tool, Gomez classification, Waterlow classification, and WHO classification criteria.[12-16] Furthermore, the study investigates the influence of demographic, clinical, and maternal factors on pediatric patients' nutritional risk.

By determining key predictors, this study aims to develop targeted nutritional interventions for pediatric surgery patients. Early identification and appropriate dietary strategies can enhance postoperative recovery and long-term health outcomes.

Main Points

- The preoperative nutritional status of pediatric surgical patients varies significantly depending on the assessment method used. WHO z-scores detect more cases of malnutrition than the Gomez or Waterlow classifications.
- Thoracic surgery, a prolonged preoperative hospital stay, and older age are independent predictors of a higher preoperative nutritional risk.
- Negative maternal feeding attitudes increase nutritional risk in children before surgery, and early screening with targeted interventions can help reduce complications.

Aim

This study aimed to evaluate the preoperative nutritional status of pediatric surgery patients and identify the factors that predict it.

Methods

Study design and patients

This study was designed as a descriptive, cross-sectional, and predictive. Data was collected through face-to-face interviews between April 2022 and October 2023 at a tertiary university hospital's pediatric surgery inpatient clinic. Informed consent was obtained from the mothers before data collection.

Inclusion criteria:

- The child was planned for elective surgery.
- The child was between 3 months and 16 years old.
- The child had been hospitalized for at least one day.
- The mother was 18 years old or older.
- The mother could read, write, and speak the local language fluently.

Exclusion criteria:

- The child was admitted to the intensive care unit.
- The child was undergoing emergency surgery.
- The child had used steroids or appetite stimulants in the last three months.
- The child was receiving enteral or parenteral nutrition therapy.
- The mother had sensory disabilities such as hearing or vision impairments.

Outcomes

The primary outcome of this study was to evaluate pediatric surgery patients' preoperative nutritional status using the STRONGkids tool, Gomez classification, Waterlow classification, and WHO classification.

The secondary outcomes included:

- Investigating the impact of children's demographic characteristics, such as gender, age, breastfeeding status, duration of breastfeeding, duration of complementary feeding, use of oral supplements, use of supplementary vitamins, and presence of chronic disease, on their nutritional status.

- Examining how children's clinical characteristics, including the type of surgery, length of hospital stays, weight, height, arm circumference, abdominal circumference, hemoglobin, hematocrit, albumin, and CRP levels, influence their nutritional status.
- Assessing the effect of maternal characteristics, such as maternal age, education level, working status, and attitudes toward feeding, on the child's nutritional status.
- Determining the predictive value of children's demographic and clinical characteristics and maternal characteristics in the preoperative nutritional assessment of pediatric surgery patients.

Sample size estimation

The sample size was determined using the G*Power 3.1.9.2 software.[17] Based on a medium effect size (0.05), a theoretical power of 0.80, and a 95% confidence interval[18], the minimum required sample size was calculated as 98. However, 162 children and their mothers voluntarily participated in the data collection. A post-hoc power analysis was performed to verify the sample size's adequacy. Using the mean scores of the Mothers' Attitudes Towards the Feeding Process Scale (MATFPS) according to the STRONGkids tool, the effect size was determined as 1.17, yielding a post-hoc power of 1.000, with an alpha value of 0.05.

Assessment of nutritional status

Demographic and Clinical Characteristics: A structured form, developed based on the relevant literature[19-23], was used to collect data on:

- **Child-related variables:** age, height, weight, abdominal and arm circumference, sex, preoperative diagnosis, planned surgical procedure, type of surgery, presence of chronic diseases, use of oral appliances, breast milk intake, supplementary food, and vitamin intake, length of hospital stay, and preoperative hemoglobin, hematocrit, albumin, and CRP levels.
- **Maternal variables:** age, educational level, number of children in the household and maternal feeding attitude. The Mothers' Attitudes Towards the Feeding Process Scale (MATFPS) was used to determine maternal nutritional attitudes. This 27-item scale, developed by Dilsiz and Dağ[24], is a 5-point Likert scale used to evaluate maternal attitudes toward feeding. Total scores range from 27 to 135, with higher scores indicating greater feeding-related issues. In this study, the MATFPS demonstrated high reliability (Cronbach's alpha = 0.90).
- **Nutritional Status Assessment Tools:** In 1956, Gomez introduced a classification of malnutrition based on weight below a certain percentile of the median weight for age (WFA)[13] In the 1970s, Waterlow introduced a classification based on weight for height (WFH) and also suggested the use of standard deviation scores (SD scores)[14], which have been used by the World Health Organization (WHO) since 1995.[16] Therefore, the Gomez, Waterlow and WHO classification were used in the assessment of nutritional status.

For consistency and comparative clarity, nutritional status was categorized as normal, mild, moderate, and severe across all systems: The Gomez classification for weight-for-age is as follows: normal is greater than 90%, mild malnutrition is between 75-90%, moderate malnutrition is between 60-74%, and severe malnutrition is less than 60%. The Waterlow classification for height-for-age (stunting) includes normal as greater than 95%, mild stunting as between 90-95%, moderate stunting as between 85-89%, and severe stunting as less than 85%. For weight-for-height (wasting), normal is greater than 90%, mild wasting is between 81-90%, moderate wasting is between 70-80%, and severe wasting is less than 70%. Although the WHO does not formally define "mild" wasting, for this study, z-scores between -1 and -2 standard deviations are labeled as "mild" to enable comparison across classification systems.

- **Gomez and Waterlow Malnutrition Classification:** It is based on body weight measurement and is widely used to determine the degree of malnutrition. Gomez published the first classification based on weight for age. The measured weight is evaluated by comparing it with the 50th percentile value of healthy children of the same age and gender with good nutrition (weight for age). It is widely used to determine the degree of malnutrition. The Gomez classification evaluates protein-energy malnutrition based on weight-for-age: values ≥90% are considered normal, 76–89% indicate mild malnutrition (1st degree), 61–75% indicate moderate malnutrition (2nd degree), and <60% indicate severe malnutrition (3rd degree).[13]

The Waterlow classification was developed after it was seen that weight-for-age alone was not sufficient to define the etiology of malnutrition in societies. It is used more frequently because it includes height measurement and indicates chronic malnutrition. In this classification, it distinguishes between acute malnutrition (underweight) based on weight-for-height and chronic malnutrition (stunting) based on height-for-age. The Waterlow classification distinguishes between acute and chronic malnutrition. It evaluates wasting using weight-for-height (WFH) for children under 5 years or BMI-for-age for children aged 5 years and older—not directly BMI values, and stunting using height-for-age (HFA).[14]

- **World Health Organization (WHO) Growth Standards:** This classification undernutrition is assessed using weight-for-length/height z-scores in children under 5 years of age and BMI-for-age z-scores in children aged 5 years and older. In this study, children with a z-score below -2 SD were classified as undernutrition, and those with a z-score below -3 SD were defined as severely undernourished, in accordance with WHO criteria (WHO, 1995). Although WHO does not define "mild" wasting, for the purpose of this study, values between -1 and -2 SD were categorized as mild malnutrition to allow consistent comparisons with the Gomez and Waterlow classifications.[16] According to the WHO criteria:
  - Wasting is defined as a weight-for-height (for children under 5) or BMI-for-age (for children aged 5 and older) z-score below -2 SD, with severe wasting defined as below -3 SD.
  - Stunting is defined as a height-for-age z-score (HFA) below -2 SD.
  - The WHO classification does not formally define mild wasting; however, z-scores between -1 and -2 SD may indicate a nutritional risk.

Additionally, based on the 2022 ESPGHAN definition, undernutrition is considered a condition resulting from imbalanced nutrition or abnormal nutrient utilization, leading to negative effects on tissue function or body composition. This definition includes both static z-score thresholds and dynamic changes such as a decline of more than 1 SD in weight-for-age (WFA), weight-for-height (WFH), or BMI-for-age over time, as well as growth faltering and the broader clinical context.[25]

- **STRONGkids Tool:** This screening tool was developed by Hulst et al.[12] to assess the risk of malnutrition in hospitalized children aged 1 month to 18 years who have been admitted for at least one day. The validity and reliability of the STRONGkids tool have been assessed in various populations, including Turkish children, as demonstrated in the study by Oruçoğlu and İnanç.[26] This tool evaluates four key components: subjective clinical assessment, high-risk disease condition, reduction in food intake, and weight loss, which generate a final score. A score of 4 to 5 indicates a high risk of malnutrition, while a score of 1 to 3 points suggests a moderate risk. A score of 0 points signifies a low risk of malnutrition.[27-29] This classification helps in the early identification of malnutrition risk, allowing for timely interventions and appropriate nutritional support.

Procedure

The study was conducted in a pediatric surgery inpatient clinic following the American Society of Anesthesiologists (ASA) preoperative nutrition guidelines. Clear liquids were allowed for up to two hours before surgery for all ages, while breast milk was permitted up to four hours before surgery for infants. Formula and cow's milk were allowed up to six hours before surgery, and carbohydrate loading was performed two to three hours preoperatively. Routine preoperative laboratory samples were collected from electronic patient files to minimize additional blood drawings. Data on hemoglobin, hematocrit, CRP, and albumin levels and preoperative diagnosis, surgical plan, and hospitalization details were retrieved electronically. The same investigator took anthropometric measurements within the first 48 hours of hospitalization. Depending on the child's age, weight was measured using digital baby scales or adult weight scales. Height was measured supine for infants under two years old, with the head and feet fixed, while children over two years were measured standing using a wall-mounted stadiometer. Arm and abdominal circumferences were measured between 7:00 and 8:00 AM using standardized Baxter height and weight devices. Additionally, mothers were given the MATFPS questionnaire, which they completed within 10 minutes.

Statistical analysis

IBM SPSS Version 24.0 (IBM Corp.) was used for data analysis. Normality tests included Kolmogorov-Smirnov, Shapiro-Wilk, Kurtosis-Skewness tests, kurtosis-skewed coefficient values, Q-Q plots, and box plots.[30] Nonparametric tests were applied to data that did not comply with normal distribution. Statistical significance was set at p-values less than 0.05 within a 95% confidence interval. Descriptive statistics were applied to analyze the data. Analytical statistics included Kruskal-Wallis and Mann-Whitney U tests. Given the broad age range of the study population (6 months to 16 years), raw anthropometric measurements such as weight, height, and mid-arm circumference were not used directly in statistical analyses. This adjustment ensures age-standardized comparisons, reducing bias due to natural growth variations. Additionally, multiple linear regression analysis was performed to predict the factors influencing the nutritional status of children.

Logistic regression analysis evaluated the significant variables according to the primary analysis.[31] p-values of 0.05 were considered statistically significant. The Hosmer-Lemeshow test was conducted to assess the model's fit. If the P value is above 0.05, the model's predictive value can be considered high. In this study, the Hosmer-Lemeshow test's value was 0.89, indicating the model's high predictive value.

Ethics

Ethical permission was obtained (Decision no:2022/06-13; Date:16.02.2022) from the non-interventional ethics committee of the university to which the institution is affiliated, and written permission (Number: E-59537164-799-233459, Date: 22.04.2022) from the hospital where the study was conducted. Written informed consent was obtained from each subject or relative following a detailed explanation of the objectives and protocol of the study, which was conducted by the ethical principles stated in the "Declaration of Helsinki".

Results

Table 1 evaluates preoperative nutritional status in pediatric surgery patients using three different classification methods: Gomez (weight-for-age), Waterlow (height-for-age), and WHO classification (z-score). According to the Gomez classification, 66.0% of children were classified as usual, while 6.2% were severely malnourished. The Waterlow classification showed that 76.5% of children had normal height-for-age, with 3.1% classified as severely stunted. In contrast, WHO classification (z-scores) indicated that only 50.0% of children were in the normal range, while 4.9% were severely malnourished. In contrast, according to WHO classification (z-scores), 50.0% of children were in the normal range, while 4.9% were severely malnourished when calculated without distinction of age.

In calculations made independently of the table, 52.5% of children under 5 years of age were in the normal range, while 4.9% were severely undernutrition. Among children over 5 years of age, 50.0% were in the normal range, while 4.2% were severely undernutrition. In addition, analyses according to WHO classification showed that 3.1% were stunting (Height-for-age (HFA)), 24.1% were wasting (Weight-for-height (WFH) <5 years, BMI-for-age ≥5 years), and 3.1% were undernutrition (Weight-for-age (WFA)). These differences highlight the varying sensitivity of different assessment methods in assessing nutritional risk.

Table 2 analyzes child-related demographic variables based on STRONGkid's nutrition risk groups. Gender distribution showed a statistically significant difference among risk groups (p=0.03), with boys and girls distributed differently across the low, medium, and high-risk categories. Age group classification did not significantly correlate with nutrition risk (p=0.15). Additional vitamins

Table 1. Evaluation of preoperative nutritional status in pediatric surgery patients using different assessment methods (n=162)

	Weight by age (Gomez Classification)	Height for age (Waterlow Classification)	WHO classification (WFA/BMI)
	n (%)	n (%)	n (%)
Normal	107 (66.0)	124 (76.5)	81 (50.0)
Mild	27 (16.7)	23 (14.2)	58 .835.8)
Moderate	18 (11.1)	10 (6.2)	15 (9.3)
Severe	10 (6.2)	5 (3.1)	8 (4.9)

*z-scores are calculated according to WHO references

Table 2. Analysis of child-related demographic variables according to STRONGkids nutrition screening tool risk groups (n=162)

Child-related variables	STRONGkids Nutrition Screening Tool Risk Grouping			Test statistics	p-value
	Low risk (I)	Medium risk (II)	High risk (III)		
Gender n, (%)				X^{2***}= 6.56 Cramer's V=0.20	**p=0.03**
Girl	6, (9.4)	41, (64.1)	17, (17.3)		
Boy	24, (58.2)	57, (58.2)	17, (17.3)		
Child's age group n, (%)				X^{2****}=11.67 Cramer's V=0.18	p= 0.15
Infant	3, (13.6)	11, (50.0)	8, (36.4)		
Toddler	6, (27.3)	10, (45.5)	6, (27.3)		
Preschooler	6, (16.7)	21, (58.3)	9, (25.0)		
School-age child	10, (22.2)	27, (60.0)	8, (17.8)		
Teenager	5, (13.5)	29, (78.4)	3, (8.1)		
Breast milk intake n, (%)	30, (19.2)	92, (59.0)	34, (21.8)	X^2=2.72 Cramer's V=00.15	p=0.222
Use of additional vitamins n, (%)	6, (9.7)	37, (59.7)	19, (30.6)	X^2=8.71 Cramer's V=0.23	**p=0.01**
Taking oral supplements n, (%)	7 (11.1)	37, (58.7)	19, (30.2)	X^2=7.23 Cramer's V=0.21	**p=0.02**
Chronic disease n, (%)	2 (3.2)	43, (69.4)	17, (27.4)	X^2=18.23 Cramer's V=0.31	**p<0.01**
Type of surgery n, (%)				X^2=23.40 Cramer's V=0.27	**p<0.01**
Abdominal surgery	7, (10.0)	48, (68.6)	15, (21.4)		
Thorax surgery	5, (11.6)	22, (51.2)	16, (37.2)		
Genitourinary surgery	18, (36.7)	28, (57.1)	3, (6.1)		
Child's age (years)*	6.29±4.62	7.80±4.03	4.71±4.01	F^{****}=5.58 II<III	**p<0.01**
Duration of breastfeeding (months)*	15.23±10.21	9.31±8.05	7.23±1.11	F=8.376 I<II	**p<0.01**
Time to start supplementary food (months)*	5.38±1.76	5.47±2.86	5.17±3.77	F=0.132	p=0.87
Preoperative length of hospital stays (days)*	1.60±1.06	3.95±4.15	9.20±11.84	F=12.93 I<III	**p<0.01**
Child's weight (z score) *	0.11±0.60	0.07±0.87	0.05±0.92	F=0.04	p=0.95
Child's height (z score) *	-0.10±0.72	0.05±0.84	0.12±0.82	F=0.66	p=0.51
Child's arm circumference (z score) *	0.09±0.80	-0.14±0.79	0.04±0.82	F=1.40	p=0.24
Child's abdominal circumference (z score) *	-0.04±0.85	-0.00±0.86	0.15±0.72	F=0.600	p=0.55
Preoperative hemoglobin (g/dL) *	12.18±0.91	12.06±2.09	10.81±1.67	F=6.54 I<III	**p<0.01**
Preoperative hematocrit (%) *	36.50±2.85	36.66±5.25	33.43±4.50	F=6.06 I<III	**p<0.01**
Preoperative albumin (g/dL) *	44.88±2.73	43.25±5.88	40.90±6.45	F=4.18 I<III	**p=0.01**
Preoperative C-Reactive Protein (mg/dL) *	2.18±2.90	15.81±30.44	23.24±43.41	F=3.80 I<III	**p=0.02**

*= data is given as mean± SD
X^{2***}= Pearson's chi-squared test
X^{2****}= Fisher's exact test, Cramér's V= effect size measurement for the chi-square test of independence
F^{*****}= ANOVA test
Row percentages were taken from chi-square tables.

and oral supplements were significantly higher in the medium and high-risk groups (p=0.01 and p=0.02, respectively). Children with chronic diseases were predominantly in the medium and high-risk categories (p<0.01), and the type of surgery was also significantly associated with nutrition risk (p<0.01). Furthermore, the length of hospital stay was significantly longer in the high-risk group (p<0.01). Preoperative laboratory values, including hemoglobin, hematocrit, and albumin levels, were significantly lower in the high-risk group (p<0.01, p<0.01, and p=0.01, respectively), indicating a potential link between nutritional risk and preoperative health status. Additionally, C-reactive protein levels were significantly higher in the high-risk group (p=0.02), suggesting a possible inflammatory response associated with higher nutritional risk.

Table 3 examines maternal demographic variables about STRONGkids nutrition risk groups. Although maternal education level and employment status varied across risk groups, the differences were insignificant (p=0.13 and p=0.18, respectively). However, maternal feeding attitude was significantly associated with nutrition risk, with mothers of children in higher-risk groups showing a more negative feeding attitude (p<0.01). Similarly, the high-risk group's negative mood during meals and reactions to

Table 3. Analysis of maternal demographic variables according to STRONGkids nutrition screening tool risk groups (n=162)

Mother-related variables	STRONGkids Nutrition Screening Tool Risk Grouping			Test statistics	p-value
	Low risk (I)	Medium risk (II)	High risk (III)		
Mother's education level n, (%)				X^{2**}=7.00 Cramer's V=0.14	p=0.13
Primary education	5, (15.2)	45, (68.2)	11, (16.7)		
Secondary education	9, (15.8)	31, (54.4)	17, (29.4)		
High education	11, (28.2)	22, (56.4)	6, (15.4)		
Mother's working status n, (%)				X^2=3.37-8 Cramer's V=0.14	p=0.18
Working	9, (22.0)	20, (48.8)	12, (29.3)		
Not working	21, (17.4)	78, (64.5)	22, (18.2)		
Maternal age*	35.63±5.76	36.50±7.39	32.82±6.35	F^{***}=3.56	p=0.10
Maternal feeding process attitude*	52.20±18.21	61.11±2.12	68.17±19.78	F=4.93 I<II I<III	**p<0.01**
Negative mood during meals*	9.60±6.00	13.81±7.41	16.14±7.90	F=6.64 I<II I<III	**p=0.02**
Attitude towards inadequate/unbalanced nutrition*	22.23±10.03	23.87±8.67	25.94±7.62	F=12.46	p=0.23
Negative nutritional strategies*	9.30±4.25	9.42±4.56	10.85±4.73	F=1.27	p=0.28
Force feeding*	4.80±1.58	5.61±3.19	6.11±3.11	F=1.62	p=0.20
Reacting to others' opinions*	6.26±3.19	8.37±4.59	9.11±4.61	F=3.74 I<II I<III	**p=0.02**

*= data is given as mean± SD
X^{2**}= Pearson's chi-squared test, Cramér's V= effect size measurement for the chi-square test of independence
F^{***}= ANOVA test
Row percentages were taken from chi-square tables.

others' opinions about feeding were significantly higher (p=0.02).

Table 4 presents a binary logistic regression analysis examining factors predicting pediatric surgery patients' preoperative nutritional risk. The model, which included significant variables from Tables 1 and 2, correctly predicted nutritional risk status with an accuracy of 79.0% (Nagelkerke R^2 = 0.39, p<0.001). According to the regression analysis results, thoracic surgery patients had a 3.16-fold higher nutritional risk than abdominal surgery and genitourinary surgery patients. A one-unit increase in the child's age increased the nutritional risk by 0.86 times. Increasing the day of hospitalization by one day increased the risk of high nutritional risk by 1.11 times. Gender, vitamin use, chronic diseases, and other parameters did not make a difference regarding high risk (Table 4).

Discussion

The results of this study provide critical insight into the factors that influence preoperative nutritional risk in pediatric surgical patients. Using the STRONGkids Nutrition Screening Tool, several pediatric and maternal factors were analyzed to determine their impact on nutritional status.

This study highlights the variability in nutritional assessment depending on the classification method used. The Gomez and Waterlow classifications identified a higher proportion of children as normal. In contrast, the WHO (z-score) classification identified more cases of malnutrition. Moreover, since the WHO classification is independent of age, it demonstrated higher sensitivity, detecting more malnutrition cases, with approximately a quarter of the children classified as wasted. These

Table 4. Investigation of factors predictive of nutritional status in children before surgery (n=162).

	RR	95% C.I. for EXP(B)		Sig. – p
		Lower	Upper	
Gender	0.40	0.14	0.07	0.07
Use of additional vitamins	0.58	0.19	0.32	0.32
Taking oral supplements	0.85	0.31	0.76	0.76
Chronic disease	0.81	0.31	0.67	0.67
Type of surgery	3.16	1.14	**0.02**	**0.02**
Child's age (years)	0.86	0.76	**0.001**	**0.001**
Duration of breastfeeding (months)	0.97	0.91	0.51	0.51
Preoperative length of hospital stay (days)	1.11	1.01	**0.02**	**0.02**
Preoperative hemoglobin (g/dL)	0.78	0.49	0.29	0.29
Preoperative hematocrit (%)	0.98	0.80	0.86	0.86
Preoperative albumin (g/dL)	1.004	0.91	0.93	0.93
Preoperative C-Reactive Protein (mg/dL)	1.008	0.99	0.26	0.26
Maternal feeding process attitude	1.01	0.97	0.38	0.38
Negative mood during meals	0.99	0.89	0.85	0.85
Reacting to others' opinions	0.97	0.85	0.76	0.76
Constant	5.74		0.41	0.41

Nagelkerke R2: 0.39, p<0.001
The rate at which the model correctly predicts psychological distress: 79.0%
RR= Relative Ratio

differences suggest that reliance on a single method may lead to misclassification. In a study examining the malnutrition status of hospitalized children, 25% of children had a z-score index of less than -2 during hospitalization, and based on the measurements taken, 17.5% (10% moderate malnutrition; 7.5% of children were malnourished during hospitalization according to the Gomez malnutrition classification system. According to the Waterlow classification system, 20% of children were acutely malnourished during hospitalization.[32] A combined approach using multiple assessments may provide a more accurate nutritional risk assessment in pediatric surgical patients and help guide appropriate preoperative interventions.

This study found that gender, use of vitamin supplements, oral supplements, chronic diseases, type of surgery, child's age, duration of breastfeeding, preoperative hospital stay, and laboratory findings significantly affected the nutritional levels measured with STRONGKids in pediatric surgical patients. Similar to our study, these factors have been shown in the literature to affect nutritional levels in children negatively.[11,33,34] The lack of effect of maternal education and work status on nutritional risk was surprising. Maternal nutritional attitudes, such as unpleasant moods during meals and reactions to others' nutritional suggestions, were significantly associated with higher-risk groups. According to one study, family type and children's age-appropriate BMI influenced parental attitudes. Mothers with prominent families had higher negative attitude scores and age-related BMI. Mothers of children with eating problems were more negative.[8] In another study, nutrition education increased children's average weight by 331.42 grams.[9] It is thought that mothers' psychological and behavioral characteristics influence children's nutrition. Learning about healthy eating and reducing stress during meals may improve mothers' nutrition.

When the study examined the factors that predicted the risk of malnutrition, the notable finding was that the type of surgery significantly affected the nutritional risk. Children who underwent thoracic surgery had a 3.16 times higher risk than those who underwent abdominal or genitourinary surgery. Thoracic surgery requiring significant respiratory care has increased metabolic demand and nutritional sensitivity. Recent studies have shown that nutrition affects outcomes in pediatric thoracic surgery. Stunting increases postoperative complications in children undergoing abdominal or thoracic surgery.[2] Acute malnutrition was present in 42% of Russian children admitted to thoracic surgery units, and 70% of them were at high risk.6 Anton-Martin et al. (2018) reported that underweight children supported by ECMO had a higher in-hospital mortality rate than normal-weight children using multiple logistic regression.[3] According to our research, malnutrition affects postoperative outcomes, and the type of surgery affects nutritional risk. Children undergoing high-risk surgery, such as thoracic surgery, require preoperative nutritional screening and special treatment. Child age was another predictor of malnutrition. A one-unit increase in the child's age increased the nutritional risk by 0.86 times. This result differs from the literature[10,11,35] although older children may be at higher risk due to longer exposure to chronic diseases, more difficult surgical treatments, or inadequate preoperative nutrition. Preoperative length of hospital stay was another significant predictor of malnutrition. Hospitalization increased the risk of malnutrition by 1.11 times per day, and the risk of malnutrition increased with increasing preoperative hospital stay. Inadequate oral intake and preoperative surgical stress in the hospital may have contributed to this situation. Studies have reported that malnourished patients have longer hospital stays.[4,5] These parameters are considered necessary in the preoperative nutritional evaluation of pediatric surgical patients.

Limitation

The children's wide age range may have influenced nutritional evaluation. As children age, their metabolic needs and responses to catabolic stressors may vary, potentially affecting their nutritional status differently. To address this variability, nutritional assessments were stratified according to age groups. The study was conducted in a pediatric surgery inpatient clinic of a tertiary university hospital by the ASA preoperative nutrition guidelines, and therefore, nutritional deficiencies may have been lower. In this respect, it may not reflect the Turkish sample.

Conclusion

This study highlights the critical role of preoperative nutritional status in pediatric surgery. It also highlights the changing sensitivity of nutritional assessment methods; the WHO (z-score) classification detects more cases of malnutrition than Gomez and Waterlow. Malnutrition significantly affects surgical outcomes, recovery times, and overall health, and a significant proportion of hospitalized children are at risk, particularly those undergoing thoracic surgery. Key determinants of nutritional risk include prolonged hospital stay, age, and maternal attitudes towards nutrition. Negative maternal attitudes towards feeding have been associated with poorer feeding outcomes. This study highlights the need for early nutritional assessments and interventions to reduce malnutrition risks, especially in high-risk surgical populations, to improve postoperative recovery and long-term health outcomes. Future research should focus on expanding the understanding of nutritional risk factors in diverse pediatric populations to further improve preoperative care protocols.

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Ethical approval

This study has been approved by the Non-Interventional Ethics Committee of Dokuz Eylul University (approval date 16.02.2022, number 2022/06-13). Written informed consent was obtained from the participants.

Author contribution

The authors declare contribution to the paper as follows: Study conception and design: NGÖÖ, EAK, FV; data collection: NGÖÖ, EAK; analysis and interpretation of results: NGÖÖ, EAK; draft manuscript preparation: NGÖÖ, EAK, FV. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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