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Prevalence of Malnutrition among Iranian Pediatric Patients before and After Hospitalization (2015 To 2017): A Multicenter Study

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Abstract

Background: Malnutrition undermines the beneficial outcomes of clinical interventions and also increases hospital costs. Therefore, this study aimed to estimate the prevalence of malnutrition through a multicenter observational study at the time of admission and discharge in Iranian hospitalized children and adolescents.

Methods: The present cross-sectional study was performed on children and adolescents aged one month to 18 years from three Iranian public tertiary pediatric hospitals located in different cities of Iran. To determine the participants' nutritional status, Z-score of the weight for height (for those with 1month to 5years of age) and Z-score of BMI (for ≥5 to 18-year-old patients) were calculated using the WHO growth standards. Data were analyzed using SPSS version 23.

Results: Information about 1499 patients was collected. At the time of admission, 64% of the participants had a good nutritional status, 15.5% were at high risk of wasting, 8.4% were wasted, and 12.1% were severely wasted. Among 295 malnourished patients, the nutritional status of 182 patients (63%) had been improved at the time of discharge. Also, 23% of all subjects with normal nutritional status at the admission time (85 participants), were at risk of malnutrition at discharge. The prevalence of moderate and severe malnutrition at the discharge time was about 20%.

Conclusion: More than one-third of the hospitalized children had moderate or severe malnutrition or were at high risk. Although the prevalence of malnutrition decreased somewhat during hospitalization, some children were not malnourished at the time of admission and were malnourished at discharge.

Key Words: Adolescents, Children, Infant, Hospital Malnutrition, Malnutrition.

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1- INTRODUCTION

Malnutrition in children and adolescents is a common nutritional problem in most parts of the world (1, 2). Malnutrition is a nutritional disorder that occurs due to inadequate or excessive intake of one or more macronutrients or micronutrients and is generally divided into two categories: Over nutrition and Under-nutrition (3). Children usually suffer from malnutrition before and after hospitalization (4). Prior studies have shown that about 50-80 percent of children experience weight loss during hospitalization (5). Also, about 50 percent of children admitted to internal and surgical departments are at high risk of malnutrition, and 16 to 34 percent of hospitalized children are somewhat malnourished or at risk of malnutrition (6, 7). In Iran, the prevalence of malnutrition in hospitalized children was 37 percent according to body mass index (BMI) Z-score (8). An observational study conducted in Iran found that malnutrition has a relatively high outbreak at the time of admission (By index of weight for height) and increases during hospitalization (9).

Malnutrition slows down the growth process and increases the susceptibility to various infections (10). Also, hospital malnutrition can disrupt the treatment process, increase the duration of the child's hospitalization and the need for re-hospitalization, and ultimately raise patient costs (11, 12). Moreover, malnutrition is a major contributor to disorders including gastroenteritis, pneumonia, and other infectious diseases in children and therefore it can be said that malnutrition is associated with almost 50% of all child mortality (13, 14).

Despite the recent advances in the diagnosis and treatment of child malnutrition, the prevalence of hospitalized child malnutrition has shown no significant reduction (15). Also, the first step in tackling hospital malnutrition and taking the necessary steps to address this problem is to have complete information about the prevalence of malnutrition and its process during hospitalization. In Iran, recent studies on the prevalence of malnutrition among hospitalized children are limited and show contradictory estimations (8, 16). Therefore, the aim of this study was to estimate the prevalence of malnutrition through a multicenter observational study at the time of admission and discharge among Iranian hospitalized children and adolescents.

2- MATERIALS AND METHODS

2-1. Participants

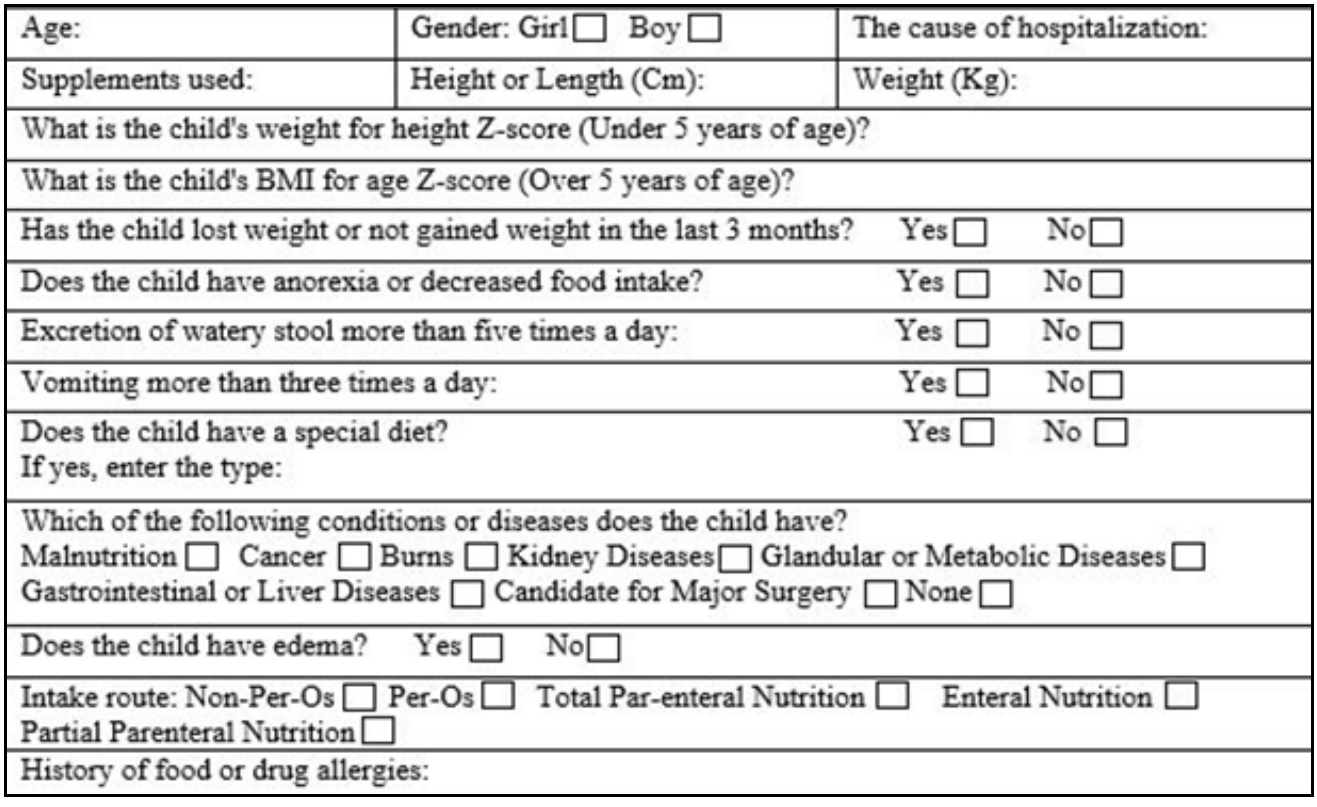
The present study was performed on children aged one month (adjusted for gestational age up to 2 years old) to 18 years from three Iranian public tertiary pediatric hospitals located in populated cities in the center (Tehran), west (Tabriz), and north (Mazandaran) of Iran. It lasted from June 2015 to February 2017.

With respect to the hospital malnutrition prevalence of 20%, power of 90%, and error level of 0.027, the sample size was calculated as n=1490 (8). Since it has been found that the occurrence of anorexia following the increase of proinflammatory cytokines in various diseases is one of the causes of malnutrition in patients, in the present study, the occurrence of anorexia as one of the causes of hospital malnutrition was investigated (20, 21).

In the data analysis, the hospital wards were divided into four main sections, including Internal wards (Gastroenterology, Rheumatology, Endocrinology, Nephrology), PICU ward, Neurology wards (Neurology, General Surgery, Neurosurgery, Allergy, Pulmonology, Thoracic surgery), and Hematology wards (Hematology, Oncology). In this study, excretion of watery stool 3 or more than 3 times a day

and lasting for 14 days or more was considered as persistent diarrhea, and also vomiting more than two episodes per week was considered as persistent vomiting (17-19).

To ensure the accuracy of the measured data, all hospitals participating in the project were provided with the required instructions. And all forms were completed by a nutritionist or trained nurse. The primary nutritional assessment form used in this study is presented in **Fig. 1**. All children underwent anthropometric and subjective assessments through their first 24 hours of hospital stay by nurses and received various diets and dietary recommendations based on the existing disease at the beginning of hospitalization by a nutritionist. The diets are summarized as follows: 1) the anti-allergic diet included the elimination of almond, peanut, milk, and dairy products, egg, and fish from the individual's routine diet. 2) The chemotherapy diet included the use of fully cooked foods and avoidance of raw foods and in case of reflux, nausea, or diarrhea, the implementation of the related diet was also suggested. 3) The diabetic diet included prescribing low glycemic index foods and splitting the carbohydrates between meals. 4) The nutritional support diet included the use of intestinal or intravenous nutrition (enteral nutrition or parenteral nutrition). 5) The malabsorption diet includes supplementation with vitamins and MCT oil and also the replacement of rice with wheat in malabsorption diseases such as celiac disease. 6) The diet for rheumatic diseases included increasing the use of colored fruits, fish, and foods containing omega-3 fatty acids and restricting the use of processed foods.



Age:	Gender: Girl☐ Boy☐	The cause of hospitalization:
Supplements used:	Height or Length (Cm):	Weight (Kg):
What is the child's weight for height Z-score (Under 5 years of age)?		
What is the child's BMI for age Z-score (Over 5 years of age)?		
Has the child lost weight or not gained weight in the last 3 months?	Yes☐	No☐
Does the child have anorexia or decreased food intake?	Yes☐	No☐
Excretion of watery stool more than five times a day:	Yes☐	No☐
Vomiting more than three times a day:	Yes☐	No☐
Does the child have a special diet? If yes, enter the type:	Yes☐	No☐
Which of the following conditions or diseases does the child have? Malnutrition☐ Cancer☐ Burns☐ Kidney Diseases☐ Glandular or Metabolic Diseases☐ Gastrointestinal or Liver Diseases☐ Candidate for Major Surgery☐ None☐		
Does the child have edema? Yes☐ No☐		
Intake route: Non-Per-Os☐ Per-Os☐ Total Par-enteral Nutrition☐ Enteral Nutrition☐ Partial Parenteral Nutrition☐		
History of food or drug allergies:		

Fig. 1: The primary nutritional assessment form for children and adolescents

2-2. Anthropometric measurements

Weighing scales and stadiometers in each hospital were calibrated prior to the commencement of the study and at regular intervals until the end of the study. In one meeting, all the people who had the task of recording anthropometric measurements were taught the correct method of measuring height and weight. Barefoot body weight was measured with light clothing by the Seca digital scale with an accuracy of 100 grams. In children under 2 years of age, length was measured in the supine position using an infantometer (Seca, Germany), and in children over 2 years of age, height without shoes was measured using a stadiometer with an accuracy of one millimeter (Seca, Germany). For children who were older than 2 years old and when a direct measure of height was not possible, height was estimated from knee height (22). To measure knee height, the child was seated upright without shoes and socks with feet flat on the floor, with both the knee and the ankle joints flexed at an angle of 90°. The measurement was taken as the distance from the floor, or foot rest, to the anterior surface of the thigh just proximal to the patella. The shaft of the caliper was held parallel to the tibia and mild pressure was applied to the blades of the caliper to blanch the skin and compress the tissue; for this measurement, a caliper rule with an accuracy of one millimeter was used. Body mass index (BMI) was calculated in all children over five years of age. To determine the participants' nutritional status, Z-score of the weight for height (for those with 1month to 5years of age) and Z-score of BMI (for ≥5 to 18-year-old patients) were calculated using the WHO growth standards. Malnutrition was defined according to WHO benchmarks for anthropometric parameters using the Z-scores: Patients with Z-scores less than -3SD were considered as severely wasted, those with Z-scores from <-2 to -3 wasted, and those with Z-scores from <-1 to -2 at risk of wasting (23). All anthropometric assessments at the time of discharge were repeated and interpreted in the same way.

2-3. Inclusion and Exclusion Criteria

The patients with an age range of one month to 18 years were included in the study. The Patients excluded from the study were the children admitted to the emergency department, subjects admitted to the neonatal intensive care unit (NICU), preterm infants, neonates, hospitalized patients for less than 24 hours, children whose exact weight measurement is not possible, and patients whose height measurements are not possible even indirectly.

2-4. Data analysis

Descriptive statistical tests were performed for socio-demographic and malnutrition related variables. Bivariate analysis was performed to identify the association between the dependent and independent variables. The differences were identified in a cluster based on Chi-square tests. The data was analyzed using SPSS version 23 (SPSS Inc., Chicago, IL, USA) with two-tailed tests at $p \leq 0.05$ level of significance.

3- RESULTS

At the end of the study, information about 1499 patients was collected and analyzed. At the time of admission, 64% of these patients had a good nutritional status, 15.5% were at risk of wasting, 8.4% were wasted, and 12.1% were severely wasted according to the weight for height or BMI for age Z-scores. 12.6 percent of the girls and 11.3 percent of the boys were severely wasted on admission and there was no statistically significant association between malnutrition and gender (P=0.88). Among children older than 5 years, 9% and 13.7% had moderate and severe malnutrition, respectively. Less than 1% of children (4 overweight and 5 obese from 991 children) under 5 years of age and

9.6% of children (27 overweight and 22 obese from 508 children) over 5 years of age were overweight or obese at the time of admission. The highest percentage of malnutrition was seen in hematology wards (16.4% severely wasted), while the lowest percentage of malnutrition was found in the PICU ward, with about 7.5% severely wasted patients of all patients admitted to this ward. In addition, there was no association between malnutrition and hospitalization in different wards of the hospital (P=0.54). Also, there was no significant difference in the prevalence of malnutrition at the time of admission between those who had a history of surgery (P=0.22) or allergies (P=0.26) and the other patients **(Table 1)**.

Table-1: The patients' characteristics and prevalence of wasting at the time of admission to hospital

Variable name		None N (%)	At risk of wasting N (%)	Wasted N (%)	Severely wasted N (%)	Total (%)	P value
Gender	boy	525(63.6)	130(15.7)	67(8.1)	104(12.6)	826(55.1)	0.88
	girl	436(64.9)	102(15.1)	59(8.7)	76(11.3)	673(44.9)	
Age category	<5 years	612(61.7)	155(15.6)	89(9)	135(13.7)	991(66.1)	0.25
	≥5 years	348(68.5)	77(15.2)	37(7.3)	46(9.1)	508(33.9)	
Hospitalized wards	Internal	258(66.8)	52(13.5)	33(8.5)	43(11.1)	386(38.5)	0.54
	PICU	77(57.5)	31(23.1)	16(11.9)	10(7.5)	134(13.3)	
	Neurology	223(60.4)	59(16)	34(9.2)	53(14.4)	369(36.7)	
	Hematology	75(64.7)	14(12.15)	8(6.9)	19(16.4)	116(11.5)	
A history of surgery	yes	110(59.8)	22(12)	23(12.5)	29(15.8)	184(16)	0.22
	No	628(65.1)	157(16.3)	76(7.9)	104(10.8)	965(84)	
A history of allergies	No	152(56.1)	25(9.2)	35(12.9)	59(21.8)	271(88.6)	0.26
	yes	21(60)	4(11.4)	2(5.7)	8(22.9)	35(11.4)	
Type of Diet	Anti-allergic diet	768(74.3)	190(18.4)	75(7.3)	0(0)	1033(71)	<0.001 b
	Malabsorption diet	52(61.2)	8(9.4)	8(9.45)	17(20)	85(5.8)	
	Chemotherapy diet	1(2.1)	0(0)	0(0)	47(97.2)	48(3.4)	
	Diabetic diet	41(34.2)	17(14.25)	18(15)	44(36.7)	120(8.2)	
	Nutritional support	46(47.4)	8(8.2)	10(10.3)	33(34)	97(6.7)	
	Rheumatic diet	32(44.4)	6(8.3)	9(12.5)	25(34.7)	72(4.9)	
A history of underlying disease	No	898(59.9)	216(14.4)	103(6.9)	147(9.8)	1364(9.1)	<0.001 b
	Yes	62(45.9)	16(11.9)	23(17)	34(25.2)	135(9)	
Anorexia	Yes	41(39.0)	18(17.1)	23(21.9)	23(21.9)	105(12.8)	<0.001 b
	No	348(46.2)	136(18.0)	148(19.6)	122(16.2)	754(87.2)	

PICU = pediatric intensive care unit; N = Number of patients. Severe malnutrition for children under 5 years was defined as weight for height z-score<-3 (severely wasted) and Moderate malnutrition was defined as weight for height -3<z-score<-2 (wasted). Severe malnutrition for children older than 5 years was defined as BMI for age z-score<-3 (severely wasted) and Moderate malnutrition was defined as BMI for age -3<z-score<-2 (wasted).
P values were based on chi-square tests
[a] P value ≤ 0.05
[b] P value < 0.001

As demonstrated in **Table 1**, all children who had been in the hospital for more than 24 hours had received nutritional advice. More than 97 percent (47 out of 48 children) of those who had received the chemotherapy diet were severely malnourished. Furthermore, there was a significant difference between children who had received different diets and/or dietary recommendations at the beginning of hospitalization (P<0.001). Forty-two percent of those with a history of

underlying diseases were malnourished at the time of admission and more importantly, the prevalence of malnutrition was significantly higher in children with a history of underlying diseases (P<0.001). Overall, about 44 percent of children with anorexia had moderate or severe malnutrition, and there was a significant difference between children who had anorexia and those who did not (P<0.001). Many factors affecting malnutrition such as socioeconomic status, parental education, and occupation were examined in the present study but due to the lack of accurate answers to these questions, there was no complete data to report; and only the data on persistent diarrhea and persistent vomiting were of good quality; just about 14% (7 from 49 patients) of those with diarrhea and 16% (3 from 18 patients) of those with persistent vomiting at the time of admission were not malnourished.

As presented in **Table 2**, 63% of all subjects at risk of malnutrition at the admission time (182 participants), had a normal nutritional status at discharge. On the other hand, 38% of all subjects who were at risk of malnutrition at the admission time (113 participants), were still at risk of malnutrition at discharge. Also, 23% of all subjects with normal nutritional status at the admission time (85 participants), were at risk of malnutrition at discharge. The prevalence of moderate and severe malnutrition at discharge was about 20% and 30% with and without considering children who were at risk, respectively.

Table-2: Prevalence of malnutrition at the time of admission and discharge.

Variable name		Admission Z-score	
		Normal N	At risk of wasting or wasted N
Discharge Z-score	Normal N	279 (77%)	182 (62%)
	At risk of wasting or wasted N	85 (23%)	113 (38%)
Total N (%)		364(100%)	295(100%)

N: Number of patients.

4- DISCUSSION

This multicenter study investigated the prevalence of malnutrition in Iranian hospitalized children and adolescents at the admission and discharge time. Contrary to the previously estimated prevalence of malnutrition in Iranian children, which was between 1 to 10 percent (24-26), more than one-fifth of the Iranian hospitalized children in this study had moderate or severe malnutrition. In a study conducted in 2016 by Sotoudeh et al. (23), 41% of the patients admitted to the PICU ward who received enteral nutrition or total parenteral nutrition were malnourished. Since all of the patients in the aforementioned study were selected from the PICU ward, the higher prevalence of malnutrition was predictable. On the other hand, Malek et al. (24) on the patients admitted to a tertiary Iranian hospital estimated that the prevalence of malnutrition was about 56%. The major difference between the mentioned study and our study is the selection of different age groups (1 to 5 years) and also dissimilar sample sizes (65 patients in Malek et al. study) (27). Almost in line with our study, Moeini et al. (25) in an investigation conducted in Iran reported that the prevalence of malnutrition is almost 25%. Notably, their criteria for diagnosis of malnutrition and the age range of children were similar to our study (28). Similar to our study, in a study conducted by Imanzadeh et al. (8) at Mofid Hospital, the prevalence of moderate and severe

malnutrition in children older than 2 years was reported about 21%, but the sample size of the mentioned study was smaller and the enrolled patients were from only one hospital (8). Unlike some studies in other countries, there was no difference between boys and girls in our study regarding malnutrition and most of the studies in Iran have not evaluated the relationship between malnutrition and gender (29, 30). The reasons for the differences in the prevalence of malnutrition might have been as follows: differences in sample size, sampling from different wards, sampling from one city or hospital, and eliminating or adding various diseases in studies. In our study, we tried to control for the aforementioned factors by sampling in different cities and hospitals, with a larger sample size, and using various wards of the hospitals. In addition, our findings demonstrated that the prevalence of obesity and overweight in Iranian hospitalized children was lower than that in healthy children (31). Consistent with our findings, a study conducted on hospitalized children in Shiraz, Iran, reported a lower prevalence of obesity and overweight in the healthy pediatric population (16). The history of underlying diseases as well as anorexia in these children was also cited as less prevalent than overweight and obesity.

Although the present study estimates the prevalence of malnutrition relatively lower than other studies conducted in Iran, it is still high, and more than 15% of the pediatric patients were at risk of wasting (BMI Z-score between -1 to -2) and may progress to moderate or severe malnutrition in the future with greater weight loss. In line with our research, other studies have reported a high prevalence of children at risk of wasting or with mild malnutrition at the time of admission (8, 9, 32). Other developing countries have also reported a high prevalence of children at risk of malnutrition according to BMI Z-score (33, 34). On the other hand, in a study that assessed the risk of malnutrition by standard questionnaires, the risk of malnutrition at the time of admission was moderate and severe in all patients (35). Although our study did not assess the risk of malnutrition using a standard questionnaire, their use in future studies can be suggested for the early diagnosis and control of hospital malnutrition.

In the present study, the prevalence of wasting was significantly higher in children with anorexia or with a history of underlying diseases. Moreover, most patients with diarrhea or persistent vomiting were malnourished. However, these patients may become more malnourished because of lower calorie intake or malabsorption or in some cases due to increased metabolism, as some of these are included in the validated malnutrition risk assessment questionnaires such as NRS, PYMS, STRONGkids, and STAMP. Contrary to the other studies, the prevalence of malnutrition in different wards of hospitals had not changed significantly in our study (33). This may be due to the integration of some wards of the hospital as the main section in our study.

Although the number of people with malnutrition at the time of discharge was lower than at the time of admission, the prevalence of malnutrition at discharge time was still high. In line with our study, Malek et al. (24) in 2019 reported that an improvement had occurred in the patients' malnutrition status after discharge compared to the admission time. The city in which that investigation was done was different from the cities in our study, which can indicate the possible generalizability of our results for the whole country.

More importantly, although many children who were severely malnourished at the time of admission had improved at discharge, some children didn't have

malnutrition at the time of admission and were malnourished at discharge. Hospital practices that deteriorate the nutritional status of children during hospitalization include failure to record height and weight of children in patients' medical records, use of inappropriate growth charts for age groups, lack of a referral system to a nutritionist, lack of nutritional assessment at the time of admission and during hospitalization, inadequate nutritional training for wards staffs (36-38).

A study conducted by Emami et al. (36) showed that initial nutritional evaluation had not been performed in 34% of the patients and more than half of the reports about appetite, weight, and height included some errors. The complications regarding these cases of malnutrition and its consequences are common among various nations and could be considered as a global concern that requires vast support of policymakers and stakeholders to fight against (39-43).

In our study, the prevalence of malnutrition was significantly different in individuals receiving different diets, and in some cases such as those receiving chemotherapy diet, the prevalence of severe malnutrition was high; Considering that the patients' weight and height were measured before receiving the diet and the treatment regimen had not yet had an effect, this statistically significant difference can be attributed to the underlying disease of these individuals.

In order to add to the strengths and accuracy of the results, the current multicenter study included a large number of patients evaluated; moreover, it was a concurrent study in three hospitals; had an evaluation of the PICU ward as the area where hospital malnutrition is most prevalent; and attempted to reduce the interpersonal measurement errors by conducting training sessions for those responsible for measuring anthropometric indices in hospitals.

4-1. Limitations of the study

The Limitations of our study are as follows: 1) Data on length of hospital stay were unclear, so we were not able to report them in our research, however, we know that all patients have been hospitalized for at least one day. 2) Data on malnutrition at the time of discharge were unclear in about half of the children and we were not able to report them. 3) In the present study, the data related to height for age Z-score were not accurately calculated and could not be reported, which could be used to accurately interpret the effect of familial short stature and chronic malnutrition on the data used in the assessment of acute malnutrition (BMI for age Z-score and weight for height Z-score).

5- CONCLUSION

Overall, the findings of the present study revealed a high prevalence of malnutrition among hospitalized children at the time of admission. According to weight to height or BMI Z-score, more than 15% of children were at risk of wasting and may progress to moderate or severe malnutrition in the future with greater weight loss. Furthermore, the prevalence of overweight and obesity in hospitalized children was less than that in healthy pediatricians at the time of admission. Although the prevalence of malnutrition decreased somewhat during hospitalization, some children were not malnourished at the time of admission and were malnourished at discharge. The findings of the current study can be used for improving health policies and nutritional care management in hospitalized patients.

6- ETHICAL CONSIDERATIONS

All procedures and forms related to the nutritional status of children were approved by the Scientific Committee of the Ministry of Health, Islamic Republic of Iran, and the Ethics Committee of Shahid Beheshti University of Medical Sciences

(IR.SBMU.RETECH.REC.1396.1279).
Also, prior to the study, parents or caregivers were informed about the aims of the study, and verbal consent was obtained. Additionally, after the patients or caregivers were aware of the aims of the study, verbal consent was taken to measure the anthropometric parameters of the patients.

7- CONFLICTS OF INTEREST

None.

8- ACKNOWLEDGEMENTS

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