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Prevalence of malnutrition and energy intake in hospitalized children

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The main aim of the present study was to report the seven-year prevalence of malnutrition in a tertiary children's hospital and to assess the difference between recommendations and actual intake in paediatric inpatients. The study included 606 patients, age range from 0 months to 18 years, admitted to the Children's Hospital Zagreb. Energy intake by all routes was assessed and compared with daily requirements recommended by the Croatian nutritional standard for hospital diets. Weight and height were measured, and body mass index (BMI) with standard deviation (SD) was calculated. Malnutrition was defined using the World Health Organization (WHO) cut-off BMI Z-score SD as the most widely used criteria. Overall, 28.6% of the study population were malnourished, including 19.7% of overweight and obese patients, 8.9% of undernourished patients and 6.9% of stunted patients. Study results showed that 37% of all study patients had an average daily energy intake between 60% and 90%, and 33% above 90% of the recommended values. In conclusion, the prevalence of malnutrition, including undernutrition and overnutrition, in hospitalized children in Croatia is similar to that in Europe. It is of great importance to identify the children at risk at an early stage, so that appropriate nutritional intervention can be introduced. A simple nutritional screening tool should be implemented and used in all children admitted to the hospital. Key elements in improving dietary intake are a combination of screening, appropriate nutritional assessment, further patient monitoring, and improving the hospital menu.

Key words: malnutrition, prevalence, energy intake, hospitalized children

INTRODUCTION

Appropriate nutrition in early stages of life is crucial to ensure healthy growth, as it is known that nutritional status of children influences their immune system, physical, neurological and cognitive development, as well as other clinical outcomes (1, 2). Malnutrition can be defined as a state in which a deficiency, excess or imbalance of energy, protein and other nutrients causes measurable adverse effects on tissue, body form and function. The term malnutrition generally refers both to undernutrition and overnutrition (overweight and obesity) (3, 4). Stunting (low height for age, HfA) or linear growth faltering is a reflection of chronic malnutrition. It may be an independent condition or may occur along with wasting (low weight for height), and may even exist in the presence of overweight and obesity (5). Children have limited energy reserves and higher energy demands because of their need for growth, which puts them at a particularly high risk of malnutrition. It is well known that malnutrition in the context of undernutrition has a direct impact on morbidity and mortality in children including higher risk of treatment complications and increased medical costs (3). Dietary intake has an important role in both the prevention and treatment of childhood malnutrition (6). Accurate assessment of food intake in children and adolescents is important because dietary habits formed early in life may have considerable impact on long-term health status (7).

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TABLE 1.

YEAR	2010	2011	2012	2013	2014	2015	2016	TOTAL
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
TOTAL GROUP	91 (13.5%)	93 (13.8%)	95 (14.1%)	95 (14.1%)	109 (16.2%)	99 (14.7%)	91 (13.5%)	673
The number of patients with incomplete data	11 (12.1%)	18 (19.4%)	14 (14.7%)	2 (2.1%)	13 (11.9%)	1 (1%)	8 (8.8%)	67 (10%)
The number of patients included in the study	80 (87.9%)	75 (80.6%)	81 (85.3%)	93 (97.9%)	96 (88.1%)	98 (99%)	83 (91.2%)	606 (90%)
Gender								
M	45 (56.3%)	44 (58.7%)	47 (58%)	44 (47.3%)	54 (56.3%)	50 (51%)	45 (54.2%)	329 (54.3%)
F	35 (43.8%)	31 (41.3%)	34 (42%)	49 (52.7%)	42 (43.7%)	48 (49%)	38 (45.8%)	277 (45.7%)
Age groups								
0-3 months	2 (2.5%)	8 (10.7%)	3 (3.7%)	6 (6.4%)	1 (1%)	6 (6.1%)	8 (9.6%)	34 (5.6%)
4-12 months	4 (5%)	10 (13.3%)	13 (16%)	10 (10.7%)	7 (7.3%)	7 (7.1%)	5 (6%)	56 (9.2%)
1-3 years	23 (28.7%)	11 (14.6%)	16 (19.8%)	16 (17.2%)	19 (19.8%)	7 (7.1%)	10 (12.1%)	102 (16.8%)
4-6 years	18 (22.5%)	9 (12%)	9 (11.1%)	14 (15.1%)	17 (17.7%)	11 (11.2%)	12 (14.5%)	90 (14.9%)
7-9 years	7 (8.8%)	8 (10.7%)	7 (8.6%)	9 (9.7%)	14 (14.6%)	11 (11.2%)	14 (16.9%)	70 (11.6%)
10-13 years	14 (17.5%)	9 (12%)	19 (23.5%)	12 (12.9%)	13 (13.5%)	18 (18.4%)	8 (9.6%)	93 (15.3%)
14-18 years	12 (15%)	20 (26.7%)	14 (17.3%)	26 (28%)	25 (26.1%)	38 (38.9%)	26 (31.3%)	161 (26.6%)

The main aim of the present study was to report the seven-year prevalence of malnutrition in tertiary children's hospital and to assess the difference between recommendations and actual intake in paediatric inpatients.

PATIENTS AND METHODS

This was a seven-year comparison of the one-day cross-sectional study conducted at the Children's Hospital Zagreb. Energy intake was monitored for four consecutive years as part of the one-day cross-sectional study. Patients admitted to the general paediatric and surgery wards of the Children's Hospital Zagreb, age range from 0 months to 18 years, were included in the study. Exclusion criteria were hospitalization for less than 24 hours, children admitted to intensive care and burn ward, or inability to obtain consent from parents or legal guardians. In total 673 children were considered for enrolment in the study. Sixty-seven (10%) patients had incomplete data such as lack of anthropometric measurements or energy intake, which led to exclusion from the study. There were 329 (54.3%) male patients, and most of the study population (n=161; 26.6%) were aged 14-18 years. Results showed a statistically significant difference in the distribution of patients within different age groups according to years (χ^2-test, p=0.004). Other demographic characteristics of the study population throughout study years are shown in Table 1.

This cross-sectional study was conducted every year in November. A parent or legal guardian and children older than 12 years signed the informed consent. Demographic (gender, age and date of birth) and medical (date of admission, diagnosis, number of hospital stays during the last 12 months) data were documented during a structured interview with the patient and/or parents/guardians. Data on energy intake were collected during 24 hours by educated dietitian or nurse in all patients hospitalized for more than 24 hours. The Estimated Food Record method was used to measure food intake in the hospital. Energy intake by all routes (oral, enteral and parenteral) was assessed and analysed by the Dijetetičar hospital dietetic software and compared with daily requirements recommended by the Croatian nutritional standard for hospital diets (8).

Body weight and height in children and adolescents (length in infants and children younger than two years) were measured with calibrated standard equipment. The body mass index (BMI) standard deviation (SD) for specific age and gender was calculated using the World Health Organisation (WHO) Anthro (for children under five years) and AnthroPlus (for children aged 5-19 years) software for the global application of the WHO Child Growth Standards in monitoring growth and development of the individuals and populations.

Malnutrition was defined using the most widely used criteria for defining malnutrition in children, WHO cut-off BMI Z-score SD (3). The WHO Global Database on Child Growth and Malnutrition (9, 10) uses a Z-score cut-off point of <-2 SD to classify low BMI Z-score as moderate undernutrition and <-3 SD to define severe undernutrition. For children under five years of age, overweight is defined as BMI Z-score above 2 SD and obesity as BMI Z-score above 3 SD. For children aged 5-19 years, overweight is defined as BMI Z-score for age >1 SD and obesity as BMI Z-score for age >2 SD.

Chronic malnutrition (stunted) is defined as height/length for age (HfA) below -2 SD.

Statistical analysis

Data are presented as frequency distribution of patients with a certain nutrition level over years. Energy intake of patients from different age groups is presented as a ratio of the average energy intake and recommendations for every age group.

Baseline characteristics between the groups were compared using Pearson's χ^2-test for categorical data, while Kruskal-Wallis test was used for non-normally distributed continuous data. Statistical analysis was carried out using the IBM SPSS Statistics v 23 software, while Microsoft Excel 2016 was used for graphical presentation and data management.

RESULTS

Overall, 28.6% (n=173) of the total study population were malnourished, including 19.7% (n=119) of overweight and obese patients, 8.9% (n=54) of undernourished patients and 6.9% (n=42) of stunted patients. The prevalence of malnutrition in the study population according to years is shown in Figure 1.

Study results showed that there was no significant difference in the frequencies of obese patients (one sample χ^2-test, p=0.165) and overweight patients (one sample χ^2-test, p=0.176) according to years. In 2010, there were 8.8% (n=7) of overweight patients, followed by slight increase until 2013, when the highest prevalence of 18.3% (n=17) of patients with BMI >2 SD (for patients 0-5 years) and BMI >1 SD (for patients 5-18 years) was recorded. The prevalence of overweight patients decreased again gradually after 2013, with the final figure of 16.9% (n=14) of overweight patients in 2016, which was double the prevalence recorded in the first year of the study. Unlike overweight, the percentage of obese patients in 2016 (3.6%, n=3) was found to be lower compared to 2010 (5%, n=4), although the percentage recorded in 2013 (11.8%, n=11) was three times higher and in 2015 (7.1%, n=7) two times higher as compared with 2016.

Regarding moderate undernutrition, the prevalence did not change significantly over years (one sample χ^2-test, p=0.371). At the beginning of the study, in 2010, the prevalence of moderate undernutrition was 5% (n=5). Almost equal result was reported in 2015 (5.1%, n=5), with slight decrease to 4.8% (n=4) in 2016. The prevalence of severe malnutrition did not significantly change over years either (one sample χ^2-test, p=0.303). Concerning severe malnutrition, similar results were recorded in 2010 (2.5%, n=2) and

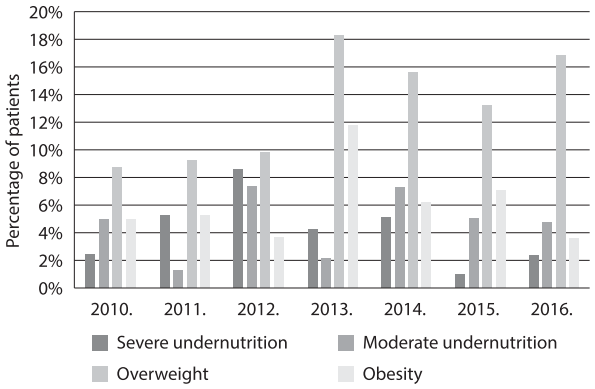

FIGURE 1. **The prevalence of malnutrition in the study population according to years.**

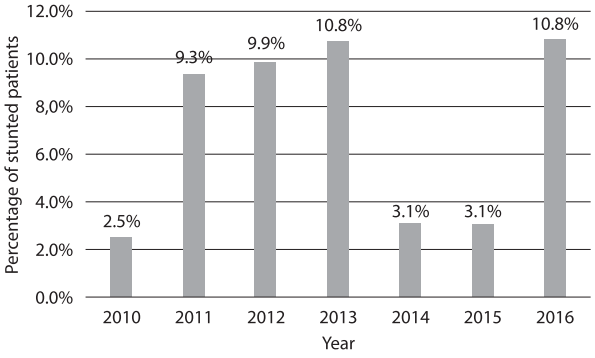

FIGURE 2. **Frequencies of stunted patients according to years.**

2016 (2.4%, n=2), while the highest prevalence of 8.6% (n=7) was found in 2012. The lowest prevalence of only 1% (n=1) of severely undernourished patients was recorded in 2015, the same as the lowest prevalence (1.3%, n=1) of moderate undernutrition in 2011.

Study results showed the lowest percentage of stunted patients with HfA<-2 SD in 2010 (2.5%, n=2). Although there was no significant difference in the prevalence of stunted patients according to study years (one sample χ^2-test, p=0.099), in 2016 the prevalence was more than fourfold that recorded in 2010 (10.8%, n=9) (Figure 2).

Table 2 shows the average daily energy intake in all study patients according to age in comparison with daily requirements recommended by the Croatian nutritional standard for hospital diets (8).

The average daily energy intake in children under one year of age was within the recommendations, except for 2014, when the intake in children aged 0-4 months was above the recommendations and 2015, when the intake in children aged 4-12 months was slightly below the recommendations. The average daily energy intake in children aged 10-13 years was also within the recommendations, with the exception of 2014, when the intake was below the recommended values. In other age groups (1-3, 4-6, 7-9 and 14-18

TABLE 2.

Year		2013	2014	2015	2016
Age	Recommendation* (kcal)	Average intake (kcal)	Average intake (kcal)	Average intake (kcal)	Average intake (kcal)
0-4 months	300-550	472.4	784.6	389.6	507.2
4-12 months	550-1100	914.4	560.2	510.4	808.6
1-3 years	1100-1300	880.7	652.5	753	681.8
4-6 years	1500-1700	924.5	893.6	1058.7	1167.7
7-9 years	1700-2000	1246.6	1318.3	1652.3	1529.8
10-13 years	1800-2200	1824.4	1629.9	1958.7	1803
14-18 years	2100-2800	1980.9	1966	1917.3	1874.2

*Croatian nutritional standard for hospital diets

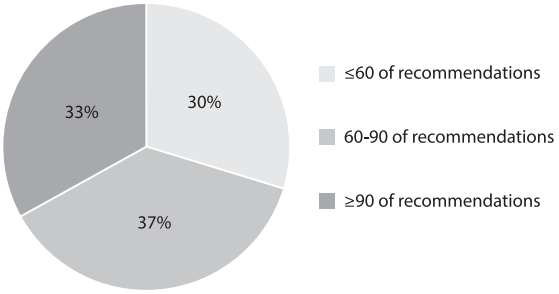

FIGURE 3. **Percentage of the average daily energy intake in patients according to recommendations*.**

*Croatian nutritional standard for hospital diets

years), the average daily energy intake was below the recommendations. The results yielded a significant difference between some of the medians of recommended calorie intake according to years (Kruskal-Wallis test, p=0.025) and age groups (Kruskal-Wallis test, p=0.000).

In four study years (2013-2016), 37% (n=138) of all study patients had an average daily energy intake between 60% and 90% of the recommended values. The average daily energy intake was below 60% of the recommendations in 30% (n=110) and above 90% of the recommended values in 33% (n=122) of patients (Figure 3).

DISCUSSION

Nutritional status in children is an indicator of health and well-being at both the individual and population levels (11). Malnutrition has been associated with an increased prevalence of complications in hospitalized children and several studies have suggested that providing appropriate nutritional support during hospital stay decreases the risk of failure to thrive and increases susceptibility to various infections (12). Malnutrition is also associated with higher morbidity resulting in an increased need for medical resources and economic expenses (11).

In European hospitalized children, malnutrition and stunting is associated with chronic underlying diseases, especially in children with disorders of the metabolic, digestive, neurocognitive and endocrine system (13). In 2008, *Joosten and Hulst* (3) summarized recent data on malnutrition in hospitalized children in a review which took into account nine surveys conducted in the period from 1990 to 2008 in different parts of the world (Germany, France, Turkey, UK, USA and Brazil). The highest prevalence of undernourished patients (31.8%) was found by Turkish research (14) and the lowest prevalence of 6.1% in a German survey conducted in 2008 (15) including 4.4% of moderately and 1.7% of severely undernourished children. These results are very similar to ours from 2010, when the prevalence of moderately undernourished patients was 5% (n=4) and from 2015, when the prevalence of severely undernourished patients was only 1% (n=1). The mean prevalence of moderately undernourished patients throughout 7 years of the present study was also 4.8% (n=29) but the prevalence of severely undernourished patients (4.1%, n=25) was higher than in the German study (1.7%) (15). More recent studies from 2014 and 2015 report the prevalence of undernourished patients from 7%, including 5% of moderately undernourished and 2% of severely undernourished children (13), to 13.3% (16) and 20.5% (15% of moderately undernourished and 5.5% of severely undernourished children) (2).

Only a few studies using the same criteria as in our study (HfA<-2SD) report the prevalence of chronic malnutrition in hospitalized children. *Hendrikse et al.* (17) and *Rocha et al.* (18) report on 8% and 18.2% of chronic malnutrition, respectively. Our study found the prevalence of stunting to range from 2.5% (n=2) to 10.8% (n=10) during the 7 years of the study, yielding the mean prevalence of 6.9% (n=42). These results are similar to more recent studies by *Aurangzeb et al.* (8.9%) (4), *Hecht et al.* (7.9%) (13) and *White et al.* (11.9%) (2).

Our 7-year follow up of overweight and obesity in hospitalized children showed the mean prevalence of 19.7% (n=119), where 6.3% (n=38) of children were obese. These results are similar to the Identification and Prevention of

Dietary and Lifestyle Induced Health Effects in Children and Infants (IDEFICS) cohort study conducted in eight European countries from 2007 to 2008 and reporting the prevalence of 28.4% of overweight and obese children (19), as well as to the study of childhood overweight and obesity trends in Cyprus, which found 28.3% of overweight and obese children (20). Our results yielded the prevalence of obesity from 3.6% (n=3) in 2016 to 11.8% (n=11) in 2013. A study conducted in a tertiary-care paediatric hospital in Pittsburgh in 2002 (21) has reported 9.7% of obese patients, which is similar to our results from 2013 (11.8%) and 2015 (7.1%). *Aurangzeb et al*. (4) and *White et al*. (2) report the prevalence of 25% and 18.7% of overweight and obese hospitalized children, respectively, which is more than double in comparison to our results from 2013 and 2015. Although our results regarding obesity indicated a lower prevalence in comparison to the above-mentioned studies, the prevalence of obesity in hospitalized children in Croatia was found to follow an increasing tendency. One of the reasons may be medical conditions caused by obesity, which make obese children hospitalized more often. Some studies used different classification systems for assessment of overweight and obesity but regardless of this, the prevalence of overweight and obesity in European children remains high and, given the tracking of body weight from childhood to adult age and its health sequelae, it represents a major public health concern (19).

Considering such a wide range of results among the studies, attention is focused on different factors that could influence the prevalence rates, such as heterogeneity and incompetence of people assessing nutritional status, diversity of population groups studied, type of institution where testing is conducted (22, 23), and inconsistent use of various criteria (3, 15). We used the WHO growth standards (9, 10) because they are currently the most widely accepted way to describe malnutrition in children. Considering that any method influences the results, as well as other factors mentioned above, any comparison with other studies may not be necessarily representative. However, the similarity of our results with previous studies can point to the relevance of our survey, indicating the need of increased awareness of the role of nutritional status in hospitalized paediatric patients.

Over the past ten to twenty years, many surveys of food and nutrient intake in children and adolescents have been undertaken but not in children's hospitals (24). Of those published, data from most of them have no meaningful use due to small and/or unrepresentative samples, poor methodology, and failure to provide sufficient details on subjects and methods (24). However, some studies have shown nutritional intake data in hospitalized patients on adult population. Thus, in 2003, *Dupertuis et al*. (25) found that up to 70% of patients did not meet the recommended disease-specific needs. These results agree with ours, where 67% (n=248) of patients had daily energy intake below 90% of the recommended values. We need to emphasize that it is comparison between adult and children population, which is known to have higher energy demands. A review article on dietary intake and nutritional status of children and adolescents in Europe from 2004 (24) reports a higher energy intake compared to the intake in hospitalized children in our study. For example, energy intake in children aged 4-6 years was 1218.9-2294.5 kcal compared to 893.6-1167.7 kcal in our four-year follow-up study. Such results were expected due to various conditions of hospitalized children. Hospitalized children often have fever, which is associated with increased energy expenditure (12). Furthermore, energy intake imbalance is often the result of overnight abdominal pain, general malaise, sense of abandonment, or alteration of taste and smell resulting from drug-nutrient interactions (12). One of the problems that we noticed in most of our patients, especially in adolescents, is the impossibility of receiving solid food from 7.00 pm to 8:00 am, with only milk and tea being available in the ward kitchen. There is a possibility of ordering night meal or additional food for some patients that are receiving modified diet but it is not the case for all of our patients. Food is distributed from the hospital kitchen to the ward kitchens, where food is plated by the nurse or auxiliary staff. Because of that, there is no guarantee that food and nutrient intake will be as defined by nutritionists/dietitians. This could be one of the main reasons why 30% of our study population had less than 60% of the recommended daily energy intake, beside the pain they suffered, the lack of appetite due to disease, unfamiliar environment away from home, and impossibility to choose only foodstuffs they liked and wanted to eat at the moment. Furthermore, overnight fasting and bowel-cleansing protocols with dietary restrictions should not be used routinely because they are nutritionally dangerous and often without any therapeutic effect (12). There is strong evidence suggesting that improvements in catering services and better organization of daily schedule in paediatric care units will increase patient nutritional intake and status, with a positive impact on the length of stay and morbidity of hospitalized children (11). Future developments in menus and preparation could involve provision of a greater variety of healthy snacks between meals and several different dishes for main meals, which would give the patients the possibility to choose what they want to eat, especially children that are very picky when it comes to eating.

Altogether, dietetic profession in Croatia is still developing. Currently, a great number of hospitals in Croatia do not even have employed nutritionist/dietitian, and in those

that do, most of the nutritionists/dietitians are working in hospital kitchens and not on the wards. The presence of nutritionists/dietitians on hospital wards is of crucial importance for better awareness and knowledge of all hospital staff, which can in turn result in lower prevalence and improved treatment of malnutrition.

The strengths of the current study are a large number of participants, educated staff who conducted the interview with the patients, and duration of the study. Also, this is the first study on food intake in hospitalized children in Croatia. The results would be even more accurate if we used weighed food record instead of estimated food record but this method was more appropriate considering that the study was conducted in a hospital with a large number of participants and limited number of educated staff. Besides this, one of the limitations of the study was collecting food intake during 24 hours every year. For future studies of this kind, it would be better to use weighed food record of 3-7 days.

CONCLUSION

Our study showed that the prevalence of malnutrition, including undernutrition and overnutrition, in hospitalized children in Croatia is similar to that in Europe. We find these results very good considering that European hospitals have more dietitians on hospital wards who work directly with patients. In order to reduce the prevalence of malnutrition among hospitalized children, a simple nutritional screening tool should be implemented and used for all children admitted to the hospital. It is of great importance to identify the children at risk at an early stage, so that appropriate nutritional intervention can be undertaken.

Furthermore, this is the first study of this kind in Croatia and a good basis for more detailed research on food intake in hospitalized children and their nutritional status. Adapting hospital menus and mealtime atmosphere to meet patient expectations may improve food intake and coverage of their needs. The provision of meals should be flexible and individualized, and all patients should have the option of ordering extra food at any time and be informed about this possibility.

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SAŽETAK

Učestalost malnutricije i energetski unos u hospitalizirane djece

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Glavni cilj ovoga istraživanja bio je izvijestiti o sedmogodišnjoj učestalosti malnutricije u djece hospitalizirane u tercijarnoj bolnici te utvrditi razliku između preporuka i stvarnog unosa pedijatrijskih bolesnika. Istraživanje je obuhvatilo 606 bolesnika u dobi od 0 mjeseci do 18 godina primljenih u Kliniku za dječje bolesti Zagreb. Energetski unos procijenjen je i uspoređen s dnevnim potrebama koje preporuča hrvatski Standard prehrane bolesnika u bolnicama. Izmjerene su tjelesna masa i visina te je izračunat indeks tjelesne mase (ITM) sa standardnom devijacijom (SD). Malnutricija je definirana primjenom prijelomne vrijednosti (ITM Z-score SD) Svjetske zdravstvene organizacije kao kriterija u najširoj uporabi. U ukupno 28.6% ispitivane populacije utvrđena je malnutricija, uključujući 19.7% bolesnika s prekomjernom tjelesnom masom i pretilih bolesnika, 8.9% neuhranjenih bolesnika te 6.9% bolesnika koji ne dostižu prosječnu tjelesnu visinu s obzirom na dob, odnosno zaostaju u razvoju. Rezultati istraživanja su pokazali kako u 37% svih ispitanika prosječan dnevni energetski unos iznosi 60% do 90%, a u 33% iznad 90% preporučenih vrijednosti. Zaključno, učestalost malnutricije uključujući pothranjenost, prekomjernu tjelesnu masu i pretilost kod hospitalizirane djece u Hrvatskoj slična je onoj u Europi. Veoma je važno prepoznati djecu u riziku u ranoj fazi kako bi se mogla uvesti odgovarajuća nutritivna potpora te bi kod sve djece primljene na bolničko liječenje trebalo napraviti procjenu uhranjenosti. Ključni elementi za poboljšanje energetskog unosa uključuju kombinaciju nutritivnog probira, odgovarajuće nutritivne procjene, daljnjeg praćenja bolesnika te poboljšanja bolničkih obroka.

Ključne riječi: malnutricija, učestalost, unos energije, hospitalizirana djeca