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RESEARCH ARTICLE

The evaluation of the malnutrition in hospitalized infants

Sinem Akbay Ak[1], Oya Baltalı[2], Özkan İlhan[3], Sezin Akman[4]

[1]Department of Child Health and Disease, Neonatology, Dr Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital, İzmir, Türkiye
[2]Department of Child Health and Disease, İzmir Tepecik Training and Research Hospital, İzmir, Türkiye
[3]Department of Child Health and Disease, Neonatology, Muğla Sıtkı Kocman University Faculty of Medicine, Muğla, Türkiye
[4]Department of Child Health and Disease, Pediatric Gastroenterology, Balıkesir University Faculty of Medicine, Balıkesir, Türkiye

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ABSTRACT

Aim: Malnutrition is a state of inadequate nutrition that can be prevented or treated with appropriate nutrition. The aim of this study is to determine the nutritional status of hospitalized infants and to establish the relationship between anthropometric measurements and malnutrition with underlying acute or chronic diseases.

Materials and Methods: This study was cross-sectional, descriptive, and noninvasive. It included the infants who were hospitalized at the tertiary hospital between 2010 and 2012. Demographic data was collected through face-to-face interviews. Body mass index (BMI), BMI standard deviation score (SDS), BMI percentiles, SDS of body weight and height were calculated using the KIGS (Pfizer International Growth Database) Auxology calculator program.

Results: A total of 298 infants were included in the study. The mean age of them was 7.18 ± 4.8 months and 185 children (62.1%) were male. At the time of hospitalization, 101 (33.9%) patients had chronic disease. Neurological diseases were the most common chronic diseases, accounting for 31.7% (n=32) of the chronic diseases. As the severity of malnutrition increased, the likelihood of accompanying chronic illness increased ($p<0.05$). In the presence of chronic disease, anthropometric measurements of infants were significantly lower ($p<0.05$). There were significant correlations between the presence of chronic illness, lenght of hospitalization, relative weight, and BMI percentiles ($p <0.05$).

Conclusion: Mild and moderate malnutrition was detected even in patients who were admitted with acute illness and were not accompanied by chronic disease. Early diagnosis and treatment of nutritional disorders can be important in reducing mortality and morbidity. The aim of the treatment of malnutrition detected during hospitalization should provide better recovery and improvement, increase the quality of life, and raise healthy individuals.

Keywords: chronic disease, hospitalization, infant, malnutrition

Corresponding author: Sinem Akbay Ak **E-mail:** sinemakbay@gmail.com
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INTRODUCTION

Malnutrition is a state of inadequate nutrition that can be prevented or treated with appropriate nutrition (1,2). Especially in underdeveloped and developing countries, it remains a serious public health problem. Since infancy is a period of rapid growth and development, nutritional problems can easily lead to both malnutrition and health problems in the child's future life (1-3). In the evaluation of nutritional status and degree of malnutrition, in addition to history and physical examination findings, children's height, body weight, and body mass index (BMI) measurements are compared with normal values of the same age group. Anthropometric assessment, especially in early childhood, allows early diagnosis of malnutrition and is useful for long-term follow-up (1,2,4). This study aimed to investigate the relationship between malnutrition in hospitalized infants and the sociodemographic characteristics of their parents, the presence of underlying acute or chronic diseases and anthropometric measurements.

MATERIALS AND METHODS

This study is cross-sectional descriptive and noninvasive. It was planned to include infants who were hospitalized at a tertiary hospital between 2010 and 2012. The mothers were informed about the study and then the study was administered to children and their mothers who agreed to participate. The infants whose parents didn't give their consent and those with missing records were excluded. The remaining 298 infants were included in the study. The purpose of the study was to evaluate malnutrition in the hospitalized infants.

The study was approved by the Clinical Research Ethics Committee of İzmir Tepecik Training and Research Hospital (No: 2010/2;6), and all procedures were performed in accordance with the Declaration of Helsinki and with the ethical standarts of the national research committee.

The number of hospitalizations, birth weight, duration of breastfeeding, presence of underlying diseases were noted in a face to face interview. The cases with more than one hospitalization were included in the study once. Premature babies were evaluated according to the corrected age. The birth weights of the cases below the 10th, between the 10-90th percentile and above the 90th percentile of gestational age (GA) were classified as small for GA (SGA), appropriate for GA (AGA) and large for GA (LGA), respectively. At the time of the survey, the current duration of breastfeeding (in months) was recorded. Patients who exclusively breastfed for the first six months and were only breastfed for less than six months were classified as sufficient, and those only received human milk for less than six months were classified as insufficient. The timing of the introduction of complementary nutrition was categorized as early, on time, or late, based on whether it began before, at, or after six months, respectively. Anthropometric measurements were recorded in accordance with a healthy child follow-up protocol. Weight was measured with an electronic weighing machine with a sensitivity range of 0.01kg, height was measured with a portable height scale. Relative weight was calculated by dividing of the measured weight of the infant to its ideal weight (the weight of a healthy child with the same height). Also, BMI, BMI standard deviation score (SDS), BMI percentiles, SDS of body weight and height were calculated using the KIGS (Pfizer International Growth Database) Auxology calculator program. A tool called "Holtain skinfold caliper" was used to evaluate subcutaneous fat tissue and triceps skin thickness was measured at the triceps region of the left arm. The middle limb was measured with the standard tape on the middle of the left arm. Acute and chronic diseases were classified as respiratory system diseases, cystic fibrosis, urogenital system diseases, gastrointestinal system (GIS) diseases, neurological diseases, motor mental retardation, heart diseases, infectious diseases, connective tissue diseases, metabolic diseases, hematological diseases, immunodeficiency and dermatological diseases, and diseases not included in this category were grouped as 'other'.

The data obtained in the study were recorded in Statistical Package for Social Sciences (SPSS) for Windows 20.0 program for statistical analysis. Demographic and socio-demographic characteristics of children and their families were evaluated by frequency analysis. Chi-square and T-test were used for the comparative statistics. The results were evaluated as 95% confidence interval, $p<0.05$ was statistically significant.

RESULTS

The mean age of the 298 patients aged 1-24 months was 7.18 ± 4.8 months (median=6 months). Of these, 185 children (62.1%) were male; 152 (51%) children were between 1-6 months old, 108 (36.2%) were between 7-12 months old, and 38 (12.8%) were between 13-24 months old. Twenty six (8.7%) cases were SGA. The median lenght of hospital stay was nine days (1-139 days). The median number of previous hospitalizations and siblings of the patients were two (1-12), one (1-7), respectively. Considering the educational status of the family members; 35 (11.7%) mothers and 12 (4%) fathers were illiterate, 189 (63.4%) mothers and 196 (65.8%) fathers had only primary school education.

The median duration of breastfeeding was 4 months, and the median duration of exclusive breastfeeding was 2.5 months. However, the age at the time of the study was indicated as the time of the intake of breast milk, so this information cannot give us a definite judgment as the duration of breastfeeding for the whole patient group. The patients who were breastfed exclusively for less than six months were termed as insufficient were 57.4% of the cases. The number of patients receiving the complementary nutrition was 241; 57.4% of these patients started early. The median at which cow milk was introduced was 9.5 months. Besides, 24 patients (8.1%) were using enteral feeding tubes because of underlying diseases. During the study, 180 patients were between 4-12 months old and only 56.7% (102) of them were receiving iron supplements.

At the time of hospitalization, 101 (33.9%) patients had chronic diseases. Neurological diseases were the most common, accounting for 31.7% (n=32) of all chronic diseases and GIS was the second most common system with chronic diseases (18.8%).

Infants who were exclusively breastfed had statistically higher BMI percentiles and relative weight and fewer hospitalizations than patients who were not breastfed sufficiently ($p<0.05$). Patients with BMI below 5th percentile, between 5th and 85th percentiles, and above 85th percentile were grouped as underweight, normal weight, and overweight, and their percentiles were 19.8%, 61.4% and 18.8%; respectively. The relative weights of 54.7% (163) of the patients were between 90%-110% and were evaluated as normal. There was a positive correlation between relative weight and triceps thickness, arm circumference. The thickness of the triceps and the arm circumference decreased, as the relative weight decreased [Pearson correlation coefficient, $r=0.376$ (CI 0.23-0.52) and $r=0.37$ (CI:0.23-0.51)] ($p<0.001$ and $p<0.001$).

The infants were grouped according to their acute illnesses at the time of admission. The most common was respiratory system diseases with 54.7% (n=163), while infectious diseases were the second (n=69, 23.2%). Severe, moderate and mild malnutrition according to relative weight were observed in 6.9% (n=7), 14.9% (n=15) and 29.7% (n=30) of the cases with chronic diseases, respectively. Severe, moderate and mild malnutrition by relative weight were found in 1% (n=2), 3% (n=6) and 17.3% (n=34) of the cases without chronic diseases, respectively. As the severity of malnutrition increased, the likelihood of accompanying chronic disease increased ($p<0.05$). In the group of patients with chronic disease, 25% of the cases with nutritional deficiency (having less than 90% of relative weight) were diagnosed with neurological disease and 21.2% of them had heart diseases, and there was a significant correlation between type of chronic disease and relative weight ($p<0.05$) (Table 1).

Infants with chronic diseases were most frequently hospitalized with respiratory system diseases (40.6%). Infectious diseases were the second most common cause of admission (21.8%). It was found that infants with body mass index (BMI) less than the 5th percentile and chronic diseases were most frequently hospitalized due to infectious and respiratory diseases (41.5% and 29.3%; respectively). In the presence of chronic disease, anthropometric measurements of cases were found to be significantly lower ($p<0.05$) (Table 2).

Table 1. Comparison of relative weight and type of chronic diseases

	Relative weight		
	<%90 n (%)	**%90-110 n (%)**	**>%110 n (%)**
Neurological diseases	13 (%25)	17 (%42.5)	2 (%22.2)
GIS[1] diseases	7 (%13.5)	9 (%22.5)	3 (%33.3)
Heart diseases	11 (%21.2)	5 (%12.5)	0 (%0)
Others	7 (%13.5)	3 (%7.5)	1 (%11.1)
Cystic fibrosis	5 (%9.6)	1 (%2.5)	0 (%0)
Metabolic diseases	4 (%7.7)	1 (%2.5)	1 (%11.1)
Urogenital diseases	1 (%1.9)	2 (%5)	0 (%0)
Hematologic diseases	2 (%3.8)	1 (%2.5)	0 (%0)
Respiratory system diseases	1 (%1.9)	1 (%2.5)	0 (%0)
Chronic renal diseases	0 (%0)	0 (%0)	1 (%11.1)
Connective tissue diseases	0 (%0)	0 (%0)	1 (%11.1)
Immune deficiency	1 (%1.9)	0 (%0)	0 (%0)

[1]GIS: Gastrointestinal system

Table 2. Comparison of demographic findings with presence of chronic illness

	Chronic illness			
	Present	**Absent**	**p**	**CI %95**
Weight (kg)	6.07±2.22	7.55±2.23	**<0.001**	(-2.02)-(-0.95)
Height (cm)	62.77±9.02	66.27±8.45	**0.001**	(-5.58)-(-1.41)
BMI[1] (kg/m^2)	14.88±2.57	16.84±2.18	**<0001**	(-2.52)-(-1.40)
BMI SDS[2]	-1.35±1.88	0.31±1.59	**<0.001**	(-2.07)-(-1.25)
BM Percentile	25.34±31.74	55.84±33.00	**<0.001**	(-38.35)-(-22.66)
Weight for age (SDS)	-1.79±1.39	-0.23±1.21	**<0.001**	(-1.87)-(-1.26)
Height for age (SDS)	-1.64±2.02	-0.26±1.45	**<0.001**	(-1.78)-(-0.98)
Triceps thickness (cm)	8.85±2.77	11.45±2.15	**<0.001**	(-3.17)-(-2.03)
Arm circumference (cm)	11.76±2.18	13.44±1.69	**<0.001**	(-2.13)-(-1.23)
Relative weight	91.35±17.80	99.55±12.75	**<0.001**	(-11.72)-(-4.66)
Number of hospitalizations	2.89±1.98	1.61±0.87	**<0.001**	0.96-1.61
Lenght of hospitalization (day)	20.56±23.71	9.61±5.54	**<0.001**	7.46-14.45
Age (month)	7.54±4.64	6.99±4.87	0.347	(-0.60)-(1.71)
Birth weight (kg)	1.87±0.39	1.97±0.29	**0.011**	(-0.18)-(-0.02)

[1]BMI:body mass index, [2]SDS: standart deviation

While 37.9% (n=113) of the cases were hospitalized for more than 10 days, 54% (n=161) of the patients had been hospitalized before. A significant relationship was found between the lenght of hospitalization and the presence of chronic disease, relative weight and BMI percentiles ($p < 0.05$). The lenght of hospitalization was found to be significantly higher in patients with malnutrition ($p=0.013$). The number of hospitalizations was found to be significantly higher in those with chronic diseases, in the group with low relative weight and BMI percentiles, nutritional problems and low-income levels ($p<0.05$).

DISCUSSION

Healthy nutrition in childhood is defined as nutrition that meets all the energy and nutritional requirements necessary for the child to survive healthy and grow and develop (5). The World Health Organization (WHO) defines the protein energy malnutrition (PEM) as "a group of pathological syndromes, often associated with infections, most commonly seen in infants and young children and as a result of dietary deficiencies of protein and calorie" (2,6). Every year, 1-5% of children under the age of five worldwide die due to severe malnutrition (7). Recognition of cases with severe PEM is easy, but the detection and treatment of mild to moderate PEM are difficult to diagnose, the determination and resolution of their causes will reduce the morbidity and mortality, as well as the economic burden (8,9). In our study, malnutrition was detected in 31.5% of hospitalized infants.

Factors that play a role in the etiology of malnutrition are often based on the economic, psychosocial, and cultural factors (1,2). In a study conducted by Hendricks et al. in 2006 (10), it was reported that maternal education was the most important factor in the child's nutrition. According to data from the Turkish Population Health Surveys (TDHS) in 2008, 1/5 of the women were illiterate and hadn't completed primary school (11). Similarly, in our study, 19.8% of the mothers were non-literate and did not graduate from primary education. In addition, there was a negative correlation between family income and hospitalization.

The first two years of life are the period of most rapid growth and development, and proper nutrition during this period has important implications for older ages (12). The American Academy of Pediatrics (AAP) also recommends exclusive breastfeeding for the first six months of age (13). In the worldwide, exclusively breastfeeding rate of infants between 0 and 6 months of age is 34.8%, most of whom started complementary nutrition early (14). We found that the proportion of patients who received only breast milk for the first six months was 42.6%. The ratio of weight for height and BMI percentiles were found significantly higher and the number of hospitalizations were significantly lower in patients who were exclusively and sufficiently breastfed, compared to infants were not ($p<0.05$). The AAP issued a report in 2010 suggesting iron prophylaxis for term infants who were exclusively breastfed after four months of age (15). In our study, it was determined that 56.7% of the 180 patients between 4-12 months old were receiving iron prophylaxis. For this reason, we think that we have deficiencies in monitoring healthy children for iron supplementation.

Clinical findings as well as anthropometric measurements and biochemical parameters are used to evaluate nutritional status in children (4,16). Anthropometric methods frequently used in the evaluation of nutritional status include weight for age, height for age, BMI, relative weight, triceps thickness, and arm circumference. However, in 1990, Davies et al. (17) showed that subcutaneous thickness was poorly correlated with body fat mass at 5, 11, and 26 weeks of age. However, in our study, significant positive correlations were detected between relative weight and triceps thickness and arm circumference [Pearson correlation, $r=0.376$ (CI: 0.23-0.52) and $r=0.37$ (CI: 0.23-0.51)] ($p<0.001$ and $p<0.001$).

Nutritional deficiencies in the hospitalized children are particularly prevalent in children with chronic illnesses (18-20). In addition, immunodeficiencies can arise from nutritional deficiencies. For this reason, diseases are more severe and septicemia develops easily, further exacerbating malnutrition. Malnutrition has effects on mortality and morbidity. Therefore, patients with malnutrition should be monitored more carefully so

that these patients are likely to be hospitalized (9,19). In our study, 33.9% of the patients had chronic illnesses, 51.5% of them had malnutrition, and 6.9% of them had severe malnutrition based on the relative weight. In our patients without chronic diseases, the incidence of malnutrition was 21.3%, whereas the incidence of severe malnutrition was only 1%. It was found that the incidence of severe and moderate mulnutrition was increased in the presence of chronic diseases ($p<0.05$). In addition, anthropometric measurements of these patients were found to be significantly lower ($p<0.05$). Similarly, in the study by Doğan et al. (18), it was stated that nutritional deficiencies are more prevalent among those with chronic diseases and nutritional support was needed especially in patients with chronic renal failure, genetic disease, immunodeficiency and cystic fibrosis. In contrast, in our study, neurological diseases (31.7%) and GIS diseases (18.8%) were the most common chronic diseases among hospitalized infants. This difference may be due to the fact that our study group consisted of children aged 1–24 months, rather than the entire pediatric age group. In addition, in the group of patients with chronic diseases, 25% of the cases with nutritional deficiencies (less than 90% of relative weight) were diagnosed with neurological diseases and 21.2% of them had heart diseases, and there was a significant correlation between relative weight and type of chronic diseases ($p<0.05$). For this reason, we think that the increase in cases especially with chronic diseases such as neurological and cardiac diseases should be monitored more closely and nutritional support should be provided.

In a study conducted by Rocha et al. (21), the most common causes of death among children under five years of age hospitalized in Brazil were pneumonia (33%) and diarrhea (6.4%). In our study, pneumonia was evaluated under respiratory system diseases and acute gastroenteritis was evaluated under infectious diseases, and the most common causes of hospitalization were respiratory system diseases (54.7%) and infectious diseases (23.2%). Respiratory system diseases (40.6%) and infectious diseases (21.8%) were also the most frequent causes of hospitalization for patients with chronic diseases.

In a study conducted by De Moraes Silveira et al. (22) in 2008 on patients admitted to hospital between one month and 12 years old in Brazil, it was emphasized that patients with nutritional deficiencies had a longer hospital stay. Muñoz-Esparza et al. (23) also reported that children with critical nutritional condition at admission had a significantly longer hospital stay. In our study, while there was no significant difference between the level of malnutrition and the number of hospitalizations in patients with chronic disease, the lenght of hospitalization was found to be significantly higher in patients with malnutrition ($p=0.013$). We also found that 62.1% of the cases were hospitalized for less than 11 days, while 37.9% of them were hospitalized for more than 10 days. There were significant correlations between the lenght of hospitalization and the presence of chronic illnesses, relative weight, and BMI percentiles ($p<0.05$), while there was no significant relationship between the presence of nutritional problems, gender, age, and family income ($p>0.05$). Besides, the number of hospitalizations was found to be significantly higher in cases with chronic diseases, in the group with low relative weight and BMI percentiles, in the presence of nutritional problems and in low-income levels in our study ($p<0.05$).

We have to acknowledge some limitations of our study. Unfortunately, our study was conducted at a single center in Turkey, and the findings may not be representative of the entire country. In addition, our analysis was on infancy period. If we had evaluated a wider age range, we might have detected more important findings.

CONCLUSION

Malnutrition is still a serious public health problem, especially in developing countries like Türkiye. Mild and moderate malnutrition were detected even in patients who admitted with acute illness and were not accompanied by chronic disease. Therefore, it is important to evaluate nutritional status during hospitalization. Early diagnosis and treatment of nutritional disorders can be important in reducing mortality and morbidity. The aim of the treatment of malnutrition detected during hospitalization should be to provide better recovery and improvement, to increase the quality of life and to raise healthy individuals.

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Ethical approval

This study has been approved by the Clinical Research Ethics Committee of İzmir Tepecik Training and Research Hospital (approval date 06/05/2010, number 2010/2;6). Written informed consent was obtained from the participants.

Author contribution

Medical Practices: SAA; Concept: SA, OB; Design: OB; Data Collection or Processing: SAA, Öİ; Analysis or Interpretation: OB, SA; Literature Search: SAA, SA; Writing: SAA. 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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