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Research Article

Evaluation of the Effects of Malnutrition Detected in Children and Adolescents on the Adult Final Height

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Abstract

Aim: It is known that chronic malnutrition observed in the early childhood creates many negative results in adult life. Studies examining the effects of nutritional deficiency experienced at older ages and in adolescence are quite limited. In other words, the long-term consequences of nutritional defect in acute/chronic moderate or mild malnutrition patients still remains important as an issue to be investigated. For this purpose; In this study, it was aimed to determine the final adult height (predicted adult height) of children and adolescents with different age distribution and who were diagnosed with malnutrition as a result of nutritional-endocrinological anthropometric evaluations, and to compare these data with their genetic potential.

Material and Methods: The study included 21 cases diagnosed with malnutrition in the pediatric endocrinology department. After the detailed history of the cases, anthropometric measurements and physical examination, biochemistry, hormonal and micronutritional status, celiac antibody levels were evaluated. In the anthropometric evaluation of all cases, body weight, height, height deviation, bone age, target height, target height deviation parameters were used. Patients' pubertal development was determined according to Tanner-Marshall staging. In the determination of the nutritional status of the patients, data including Weight for Age (WA), Height for Age (HA) and Weight for Height (WH) were used as a nutritional anthropometric measurement using the Gomez-Waterlow classification. In addition, the predicted adult height was calculated with special formulas based on skeletal ages in all cases. Predicted adult height data were obtained using Bayley N Pinneau tables.

Results: Of the 21 cases with an average age of 9.81±4.34 years, 12 were prepubertal and 9 were pubertal. Acute episode over chronic malnutrition was found in 19 cases, chronic in 2 cases and acute malnutrition in one case. Considering the severity of malnutrition; WA parameter was determined as severe malnutrition in 1 case, mild-moderate malnutrition in 20 cases, HA parameter was determined as normal in 12 cases, mild-moderate malnutrition in 9 cases, WH parameter was determined as normal in 3 cases, mild-moderate malnutrition in 18 cases.

While the predicted adult height of all cases was 164.89±7.96 cm, the target height average of these cases was 166.5±8.09 cm. It was observed that the predicted adult height compared to the target height was the lowest in the chronic group. In seven cases with bone age below 6 years of age, the actual height deviations were distinctly behind the target height deviation. All of these cases were compatible with chronic malnutrition.

Conclusion: These results are valuable in terms of showing that malnutrition experienced in any period of growth may negatively affect the predicted adult height. On the other hand, this research; It emphasizes the importance of nutritional anthropometry in all cases with or without short stature. In addition, in another study we conducted in 11 adolescents, it was found that nutritional defect negatively affected growth by decreasing IGF1/IGFBP3 levels, and growth factors increased and growth was supported in the cases that were nutritionally supported. In this study, if the nutritional deficiency is not replaced in patients with malnutrition, it suggests that even if the actual height is not affected, there will be retardation in the final height of the patients.

Keywords: Malnutrition; Predicted adult height

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Introduction

It is known that stunting is the most prominent form of malnutrition that develops as a result of prolonged undernourishment in childhood [1]. In a joint study conducted by UNICEF, WHO and World Bank in 2014, it was found that there are 161 million stunted children in the world under the age of 5 [2]. It is also a fact that the stunting experienced in the first 2 years causes loss of height in the adult. In a study by Coly et al., It was observed that this loss could reach a maximum of 6.6 cm in girls and 9 cm in boys in stunting of 2874 children born in Senegal [3]. Also, Sunuwar et al., noted the increase in perinatal and neonatal mortality, especially in stunted mothers [4]. Studies show how chronic malnutrition affects generations negatively. Linear growth insufficiency, is shown as a marker of multiple pathological disorders associated with an increased risk of chronic disease in adult life [1]. However, while diagnosis can be easily made in severe and chronic malnutrition, the issue of long-term consequences of nutritional defect in acute, moderate or mild malnutrition remains an important topic that needs to be investigated. In other words, studies on the reflection of nutritional deficiency experienced in this period on adult life are extremely limited. The severity and duration of malnutrition becomes important in this case. Therefore, nutritional anthropometry is important in patients with nutritional deficiency. Nutritional anthropometry will be valuable as it will give an idea about the severity of malnutrition other than the duration of malnutrition, and it will be valuable in terms of allowing the necessary measures to be taken before it is late.

This study aims to investigate nutritional anthropometry, nutritional status, determination of malnutrition severity and duration (acute-chronic malnutrition) in children and adolescents other than early childhood, and to investigate the effects of these results on the estimated final height in adult life.

Material and Method

Twenty-one cases diagnosed as malnutrition in our Pediatric Endocrinology Outpatient Clinic were included in the study. After a detailed history of the cases, anthropometric measurements and physical examination, biochemistry, hormonal and micronutritional status, celiac antibody levels were evaluated. Ethical approval of this study was obtained by the Local Clinical Research Ethics Committee and written informed consent was obtained from all participants and/or their parents.

In the anthropometric evaluation of all cases, body weight, height, height deviation, bone age, target height, target height deviation; parameters were used [5]. Patients development in puberty was determined according to Tanner-Marshall staging scale [6,7]. Patients with normal variant short stature (genetic and constitutional), pathological short stature, infection, milk allergy, chronic disease, endocrinopathy, history of drug use, and severe micronutrient deficiency were not included in the study. In the determination of the nutritional status of the patients, data including Weight for Age (WA), Height for Age (HA) and Weight for Height (WH) were used as nutritional anthropometric measurements (Table 1) [8]. And accordingly, the degrees of malnutrition were classified as acute-chronic.

Classification of Malnutrition; in the classification made by Gomez, malnutrition, according to weight by age; is classified as mild, moderate and severe. However, today, the Waterlow Classification is used more often as it includes height and shows chronic malnutrition. Malnutrition in Waterlow classification; It was divided into 3 groups as wasted, stunded, wasted + stunted using ratios of weight by height and height by age. Wasting shows weight loss and acute nutritional deficiency when the height for age is normal; Stunting shows height loss and chronic nutritional deficiency when weight for height is close to normal; Wasting + stunting indicates loss of both, i.e. acute nutritional deficiency on chronic background (Table1) [8].

In investigating the long-term effects of malnutrition; Actual Height Deviation (AHD), Target Height (TH), Target Height Deviation (THD), Predicted Adult Height (PAH) were evaluated using anthropometric measurements [5,9]. Target height of the cases were calculated based on their mother and father height [10]. Skeletal age was determined by evaluating left hand wrist radiographs according to the Greulich & Pyle Method [11]. Estimated Final Heights (EFH) of all cases were calculated based on skeletal ages The Bayley N Pinneau SR Method was used to estimate adult height from skeletal age [12]. Since this method was used to evaluate patients with KY >6 years, the final height estimates in patients with KY <6

Table 1: Parameters used to evaluate nutritional status (8).

Athropometric measurements in evaluation of nutritional status	
Weight for age Weight of the patient x 100 Weight of healthy child of the same age	Indicates malnutrition in the acute period
Height for age height of the patient x 100 Height of healthy child of the same age	Indicates long-term nutritional deficiencies (stunning)
Weight for height (relative weight) Weight of the patient x 100 The weight of a healthy child of the same height	Demonstrates acute nutritional deficiency on a chronic basis

Degree of malnutrition	Weight for age Gomez classification	Height for age Waterlow classification	Weight for Height Waterlow classification	Z Score	Upper-middle arm circumfer ence measure
Normal	>90	>95	>90		
Mild (1°)	75-90	90-95	81-90		
Moderate (2°)	60-74	85-89	70-80	(-2)-(-3)	115-125 mm
Severe (3°)	<60	<85	<70	<-3	<115 mm

Table 2: Average predicted adult height evaluation of all cases.

Parameter	Mean±SD
Age (years)	9.81±4.34
Weight (kg)	24.85±11.1
Height (cm)	128.33±23.09
Bone age (years)	8.77±4.76
Target heigh (cm)	166.5±8.09
Predicted Adult Height (PAH)	164.89±7.96

years were evaluated according to the comparison of Actual Height Deviation (AHD) and target Height Deviations (THD) [5].

Results

12 of the cases were prepubertal and 9 were pubertal. Their ages ranged from 1 year to 16 years and 9 months (mean age: 9.81±4.34). Anthropometric evaluation of all cases is in (Table 2). The evaluation of the types of malnutrition detected in 21 cases is shown in (Table 3). According to these data; Case 15 acute malnutrition, cases 4 and 8 chronic malnutrition and the remaining cases (Cases 1, 2, 3, 5, 6, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21) were compatible with the definition of acute malnutrition on chronic malnutrition. Considering the severity of malnutrition in cases; The YGVA parameter was determined as light-to-moderate malnutrition in 20 patients in 1 case, light-to-moderate backward in 9 cases, and mild-to-middle back in 12 cases in 12 cases, and the YGVA parameter was determined as mild-to-middle back in 3 cases. Anthropometric evaluation according to the detected malnutrition type (Table 4).

While the estimated final height average using the Bayley N Pinneau SR. Method was 164.89±7.96 cm, the target height average of these cases was found to be 166.5±8.09. When Acute (A), Chronic (C) and acute attack on chronic malnutrition (CA) groups were examined, it was observed that PAH was at the lowest level in chronic group compared to target height (Table 5). The actual height deviations of the cases 15,16,17,18,19,20,21 under the age of 6 were distinctly behind the target height deviation (Table 4). All of these cases were compatible with chronic malnutrition.

Discussion

In the INCAP (Institute of Nutrition of Central America and Panama) study, it was emphasized that stunting due to growth retardation and chronic malnutrition in developing countries occurred in the early stages of life (first 18 months) and subsequent interventions to these cases were permanent without results [13]. Mahfuz et al., argued that it would be beneficial to give nutritional support early [14]. However, in two studies conducted in the USA in 1994 and 2013, it was emphasized that the nutritional support to be provided in the following periods will contribute to growth and lengthening, and may even provide full capture [15,16]. As a matter of fact, in a study we conducted in 2018, adolescents with nutritional shortness were given oral nutritional supportive therapy considering the caloric deficit determined after three days of recording and the

Table 3: Nutritional anthropometry of all cases.

Cases (n: 21)	AGE	SEX	WA	HA	WH	Malnutrıtıon
1	12 y 8 m	M	62.5 (moderate)	89,5 (moderate)	84,5 (mild)	CA*
2	10 y	F	66.1 (moderate)	97.8 (N)	70.9 (moderate)	CA*
3	14 y	F	76.2 (mild)	97.4 (N)	84.4 (mild)	CA*
4	16 y 9 m	F	73.5 (moderate)	94.3 (mild)	93.6 (N)	C*
5	10 y 7 m	M	69.2 (moderate)	99.2 (N)	71.2 (moderate)	CA*
6	12 y 9 m	M	85.5 (mild)	103.5 (N)	79.3 (moderate)	CA*
7	9 y 11 m	M	66.7 (moderate)	98.1 (N)	71.3 (moderate)	CA*
8	15 y 3 m	F	76.8 (moderate)	94 (mild)	97.8 (N)	C*
9	10 y 6 m	F	70.2 (moderate)	92.1 (mild)	88.4 (mild)	CA*
10	14 y 8 m	F	68.1 (moderate)	93 (mild)	84.9 (mild)	CA*
11	10y 4 m	F	66.2 (moderate)	94.2 (mild)	83.3 (mild)	CA*
12	12 y 8 m	M	47.2 (severe)	85.2 (moderate)	77.3 (moderate)	CA*
13	8 y 5 m	F	67.5 (moderate)	96 (N)	77.7 (moderate)	CA*
14	13 y 6 m	F	80.1 (mild)	96.5 (N)	90.4 (N)	A*
15	7 y 2 m	M	71.1 (moderate)	96.7 (N)	79.3 (moderate)	CA*
16	1 y 9 m	F	76.7 (mild)	97.5 (N)	78.7 (moderate)	CA*
17	9 y 7 m	M	71.6 (moderate)	97.7 (N)	76.6 (moderate)	CA*
18	5 y	F	70.3 (moderate)	94.4 (mild)	74.8 (moderate)	CA*
19	4 y 7 m	F	71.3 (moderate)	97.1 (N)	76.2 (moderate)	CA*
20	4 y 5 m	M	70.8 (moderate)	97.7 (N)	73.5 (moderate)	CA*
21	1 y 9 m	F	77.5 (mild)	93.9 (mild)	81.8 (mild)	CA*

*CA; Acute attack on chronic malnutrition; C: Chronic malnutrition; A: Acute malnutrition

Table 4: Anthropometric evaluation of cases according to malnutrition distribution.

Cases (n: 21)	AGE	Sex	Weight	Height	Puberty	TH	Bone Age	HSDS	THSDS	PAH
C										
case 4	16 y 9 m	F	41	151	P4	155	16 y	-1.99	-0.88	151.6
case 8	15 y 3 m	F	41.5	150	P5	166	15 y	-2.04	0.969	151.51
A										
case 14	13 y 6 m	F	40.5	152	P4	157	15 y	-1.21	-0.548	154.15
CA										
case 1	12 y 8 m	M	28.5	137	P2	167	11y	-2.38	-0.98	168.7
case 2	10 y	F	22.5	134	P1	160.25	9 y	-0.67	0	168.1
case 3	14 y	F	39.5	154.5	P4	156.5	15 y	-1	-0.63	156.6
case 5	10 y 7 m	M	25	139.5	P1	176	9.5 y	-0.38	0.44	174.3
case 6	12 y 9 m	M	40	160	P3	183	12 .5 y	1.65	1.55	187.57
case 7	9 y 11 m	M	22.5	135	P1	174	8.5 y	-0.37	0.12	182.9
case 9	10 y 6 m	F	26	130	P1	164.5	9 yaş	-1.81	0.716	154.57
case 10	14 y 8 m	F	36	148	P5	165	15.5 y	-2.28	0.8	149.04
case 11	10y 4 m	F	24.5	131	P2	159.5	8.5 y	-1.46	-0.126	159.17
case 12	12 y 8 m	M	21.5	130.5	P2	166.5	11.5 y	-3.25	-1.06	156.85
case 13	8 y 5 m	F	18.5	123	P1	160	7.5 y	-1.09	-0.04	156.09
case 15	7 y 2 m	M	16.5	117.5	P1	168.5	4.5 y	-1.04	-0.746	
case 16	1 y 9 m	F	8.9	81	P1	161	1 y 9 m	-1.15	0.126	
case 17	9 y 7 m	M	22.6	132	P1	179.5	5.5 y	-0.6	1	
case 18	5 y	F	12.8	105	P1	167.5	4y 2m	-0.94	1.22	
case 19	4 y 7 m	F	12.2	102	P1	159	3 y	-1.02	-0.21	
case 20	4 y 5 m	M	12.5	104	P1	175.5	3y	-0.63	0.36	
case 21	1 y 9 m	F	9	78	P1	163.5	24 m	-2.12	0.548	

Table 5: Evaluation of predicted adult height of the cases.

Malnutrition type	n	Target Height	Predicted Adult Height
CA*	18	166.5±8.09	164.89±7.96
C*	2	160.5±7.77	151.5±0.06
A*	1	157	154

effect of this treatment on anthropometry, growth rate, growth factors was evaluated at 0, 6, and 12 months [17]. In this study, height gains of the patients at 6th and 12th months; IGF-BP3 increase at 6th month; IGF-1, body mass index and increase in body weight SDS at 12 months were statistically significant. One-year height gain in all adolescents was between 2.46 and 4.75 cm. In addition, the increase in IGF1 levels, which is the main indicator of growth, was found significant (0, 6, 12 months, respectively; IGF1 levels: 323.51ng/ml 430.15ng/ml 469.30ng/ml). Another important point was that IGF1 levels remained within the safety limit during growth of height. As a matter of fact, Ocal et al., Pointed out that IGF1 levels decreased in acute and chronic nutritional deficiencies [18]. With this study, it was observed that long-term nutritional support provided a significant improvement both in growth factors and related anthropometric values in adolescents diagnosed with short stature due to nutritional deficiency [17].

Based on the first study, in this second study, it was foreseen that 21 malnourished children and adolescents with different age

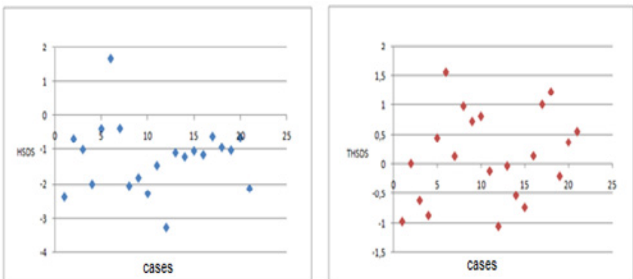

Table 6: Evaluation of cases with Bone Age <6 years based on genetics.

distribution could not reach the height that their genetics could reach by remaining behind the estimated target height. Although the number of cases is limited, this result may provide important clues and may be important in terms of showing that the negative effects of nutritional defect are reflected in justice regardless of malnutrition or the severity or type. Another remarkable aspect of the study is that it emphasizes its importance in nutritional anthropometry during routine anthropometric evaluation used in monitoring child development. As a last word, this observation in our study may be meaningful in terms of showing that the positive effects of the support to be performed in cases with nutritional deficiency, regardless of the period of childhood. These results show that more extensive studies are required.

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